YELLOW FEVER COMMISSION
(WEST AFRICA)
INVESTIGATORS' REPORTS

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THE INCORPORATED LIVERPOOL SCHOOL OF TROPICAL MEDICINE

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YELLOW FEVER COMMISSION
(WEST AFRICA)

REPORTS
ON QUESTIONS CONNECTED WITH THE

INVESTIGATION OF NON-MALARIAL FEVERS IN WEST AFRICA

VOLUME I.
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YELLOW FEVER COMMISSION

(WEST AFRICA)

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PREFACE

The Reports contained in these volumes have been received from time to time from the Investigators working under the Commission appointed by the Secretary of State for the Colonies, 'to study the nature and relative frequency of the fevers occurring among Europeans, natives and others in West Africa, especially with regard to Yellow Fever and its minor manifestations,' and from other medical men who, though not employed by the Commission, have been associated with the investigation.

Whilst accepting no responsibility for the views expressed in these Reports, the Commission are of opinion that the results of these researches conducted, as many have been, in the face of very great difficulties, should be placed on record, not only to commemorate the painstaking efforts of the investigators concerned, but also because they may prove useful as a basis for criticism and discussion, and may thus assist in the solution of the problems which still confront those whose administrative duties bring them into contact with Yellow Fever.

The Reports will be found to contain the results of investigations, and full clinical notes of many of the cases which led to their being undertaken.

J. K. FOWLER,
Chairman of the Commission.

COLONIAL OFFICE,
17th March, 1915.

TABLE OF CONTENTS

FOUR REPORTS ON YELLOW FEVER IN NIGERIA DURING 1913

BY

E. J. WYLER, M.D., B.S. (Lond.), M.R.C.S. (Eng.), L.R.C.P. (Lond.), *Medical Officer, West African Medical Staff, Southern Nigeria*

REPORT NO. 1

An investigation carried out in connection with the case of a European, who died in Lagos Hospital on May 14th, having come from Abeokuta on May 10th, 1913.

I. *General description of Abeokuta District and Town*

(*a*) Abeokuta District. Boundaries:

On the north by Ibadan District.

On the south by Lagos and Ikorodu Districts.

On the west by Ibadan, Meko and Badagri Districts.

On the east by Ibadan and Ikorodu Districts.

The most westerly part of Abeokuta District is distant from the Dahomey boundary approximately 15 miles, and the average distance of the western boundary of Abeokuta District from the Dahomey boundary is roughly 30 to 40 miles.

Area: 1,869 square miles.

Total population: 264,814, comprised of:		Census 1911.
Natives of West Africa	264,723	
Europeans	80	
Other non-West Africans	11	
Average density of native population per square mile: 141·63.		

(*b*) Abeokuta Town:

Area of inhabited portion: 3,420 acres.

Total population: 51,255.

Distance from Lagos: 64 miles.

Mean annual rainfall: 39·4 inches.

(Survey of town by E. P. Cotton, Director of Surveys, 1909.)

Situation and general description.—The town is situated on a hilly area of granite formation on the left bank of the Ogun River.

The elevation above sea-level varies in different parts by 300 feet, the surface of the river being 100 feet, and the highest point of the town 400 feet, above sea-level. The native houses are for the most part one-storeyed; their walls, with few exceptions, being built of mud, and the roofs (for the greater part without gutters) are of corrugated iron.

With the exception of about nine miles of motor-road intersecting the town in various directions there are practically no streets, houses with their compounds (enclosures) being built in a haphazard way, and separated from one another, here by footpaths of varying width, there by more or less extensive areas of 'bush' and patches of rank grass, which are allowed to grow unchecked for the most part, and serve both as public latrines and dumping grounds for tins, bottles, and garbage of all kinds.

There is no European reservation; the only part of the town which could pretend to this distinction is that in which the District and Assistant District Commissioners' and Prison Superintendent's houses are situated (on adjacent hills). In their immediate vicinity (with the exception of the dwellings of their personal attendants) there are no native houses, but a prison of considerable size, with houses for prison attendants and one or two dwellings for other native officials are situated between the two hills.

In one quarter of the town (Ibarra District) there are a number of European traders' houses, some of which are just outside the town limit. These stand among uncleared 'bush' and grass. The others, just within the town limit, are situated close to native houses, the distance varying from 20 to 58 yards, some being also in juxtaposition to more or less wide areas of uncleared bush. Mosquito-proofing of houses or rooms is practically non-existent. One or two non-officials have made ineffectual attempts in this direction.

Water-tanks are inadequately protected. I have examined a large number of them, and find that the majority abound in mosquito larvae.

II. *Rainfall*

The rains in Abeokuta were this year (and also last year) 'later' than usual. In Appendix 4 will be found, for purposes of

comparison, a table showing the rainfall (and also the average maximum shade temperature) for the months of March, April, and May, 1911, 1912, and 1913.

III. *Medical Administration*

There are two Native Medical Officers at Abeokuta. They are employed by the Abeokuta (Egba) Government. The Medical Officer (European) at Aro (about two miles from Abeokuta, on the opposite side of the river) attends to Europeans.

IV. *The patient's health prior to his illness*

I find that:

(i) He had suffered from what his friends describe as 'gastric attacks,' 'stomach trouble,' and 'chronic biliousness' for more than three years.

(ii) He suffered from boils in the left axilla and one or two on the body, which he said were very painful, about one week before going to Lagos.

(iii) For a year preceding his death he was apparently very 'run down,' and his cachectic appearance was a subject of general comment.

His occupation was arduous to him, and he complained a good deal about the excessive exertion it entailed.

He had three 'stores' (shops) to manage, and he was the only representative of his firm in Abeokuta.

One of these shops formed part of his residence, and it was necessary for him to visit the other two, which are in opposite directions at a distance of two or three miles, once a day. The journey, over a hilly road, was usually accomplished by bicycle, his motor-cycle, after the manner of some of its kind, being mostly *hors de combat*. The shops were closed daily about 3.30 p.m. He is said always to have used a mosquito-net at night.

V. *Actual movements of the patient for three months before his illness*

On consulting his diary, to which I have had access by the courtesy of his successor, it appears that he went to Lagos on Sunday, 9th February, purely on business in response to a telegram

received on the previous day from the business manager of his firm at Lagos. He stayed at Wilberforce House (where he also stayed immediately before his admission to hospital in May). He slept in a camp bed under a mosquito-net.

The manager, whom I interviewed upon my return from Abeokuta, informed me that there had been no exceptional number of cases of illness among his native employees at the time of this visit, and there are no records in Lagos Hospital of suspicious cases among his European employees.

Apart from this journey I find no evidence of the patient having been away from Abeokuta, or of his having slept elsewhere than in his house for at least three months prior to death. I have questioned his friends and also his 'boys' (servants), whom by the co-operation of his friends I succeeded in tracing. The 'boys' were, of course, well acquainted with his movements and would certainly have remembered even a short absence. There is no reason to doubt that their evidence was truthful. The patient was, however, occasionally out after nightfall, though seldom during the last month; so that, assuming that he acquired his infection in Abeokuta, he need not necessarily have done so in his own house.

I have examined the two houses which he visited in the evening during the fortnight preceding his departure for Lagos, and found *Stegomyia fasciata* larvae in both, but have been unable to obtain any history of illness in the occupants or in those living in the vicinity.

VI. *Prevalence at Abeokuta or other places visited by patient of any suspicious cases of fever*

In addition to the two Native Medical Officers who have charge of the Native Hospital, and one of whom is also Sanitary Medical Officer, there is a French Catholic Mission, the Father Superior of which, though not a qualified medical man, is an enthusiastic and successful practitioner both in surgery and medicine, and gave me every possible assistance in my enquiry.

I was informed, both by the native officers and the Father Superior, that no suspicious cases of fever had been detected. Unfortunately, however, no details of cases are recorded. Immediately after my arrival, I took occasion to explain the object

of my visit to the Reverend Father and to the native officers, and asked for their co-operation. I requested them particularly to be on the alert for mild cases of yellow fever in both adults and children, and explained verbally and in writing the points to which attention might with advantage be directed. They were also asked to be so good as to communicate with me at once on the occurrence of any suspicious case, and some weeks later the Father Superior wrote to me reporting an undoubted case of the disease in a Syrian, which has since been specially investigated.

In Appendix 1 is recorded a case of some interest that applied for treatment at the Catholic Mission while I was still in Abeokuta. No cases have been referred to me from the practice of the Native Medical Officers which could have any connection with this report.

As inquest cases in Abeokuta are referred by the District Commissioner exclusively to the Medical Officer, Aro, for *post-mortem* examination, I have examined his *post-mortem* records for 1913. There occurs amongst them one case which appears highly suspicious. In Appendix 2 will be found a copy of the *post-mortem* notes by the then Medical Officer, Aro, together with a history of the case as elicited by me from a relative of the deceased, and a commentary.

VII. *Any recent (suspicious) high mortality amongst natives at Abeokuta or other places visited by patient, especially native children*

Abeokuta.—There is no registration of births or deaths here. There does not appear to have been any recent high mortality among either adults or children. In addition to inquiries at the missions and from the Native Medical Officers, I have tried to gain information by personally visiting numerous compounds in various parts of the town, my attention being specially directed to those in the area of the cases recorded in Appendices 1 and 2, and to those around the deceased's house. The natives are, however, very reticent and suspicious. At first I was accompanied by a police officer, but fearing that this might arouse distrust, I continued my search accompanied only by a native boy. In order further to gain the confidence of the natives, I treated several cases of illness on

which I happened to light. Nevertheless, my researches under this head are with purely negative result.

Lagos.—Here, also, there does not appear to have been any suspicious high mortality during the three months preceding the patient's death (February, March and April). I attach (Appendix 5) for purposes of comparison a table showing total deaths of adults and children, and death-rates per thousand of population, respectively, for the first six months of the years 1910, 1911, 1912 and 1913. It will be seen from this that in May, 1913, there is an appreciable increase in infantile mortality.

I would add that all deaths in Lagos are registered, but that medical certification of death is not compulsory, e.g., 356 deaths were certified in a total of 2,175 deaths registered (= 16·3 per cent.).

VIII. *Number of Europeans in Abeokuta or other places visited by patient, and suspicious cases of fever amongst them within the last twelve months*

Abeokuta.—The number of Europeans resident in Abeokuta at the date of the onset of the patient's illness was 32. There was also one Syrian, who (three months later) was attacked by yellow fever. There were no suspicious cases of illness recorded during the preceding twelve months. Out of the 32 residents, I found that six had lived in regions where yellow fever is endemic (West Indies and South America) before coming to West Africa. In view of a perhaps previously acquired immunity, I have collected the figures which, for the sake of clearness, are appended in tabular form (Table 1). It will be seen, however, that, except in one case, the interval of residence in a non-endemic area after leaving the endemic area was perhaps long enough to have destroyed immunity acquired by residence in contradistinction to immunity acquired by having passed through an attack of the disease. None of these persons have ever had yellow fever so far as they are aware. From the same point of view a table (Table 2) is appended of the remaining 26 residents. In this connection it should be remarked that the deceased, though he had been in West Africa before, had, previously to his last tour, been in Europe for fifteen months, and was possibly for this reason non-immune.

Lagos.—The number of Europeans, excluding Syrians, resident in Lagos is approximately 350 (officials, approximately 105; others, approximately 245). The number of Syrians is about 60. I have examined the hospital records from the commencement of the year 1912 up to the time of the patient's death, in May, 1913, and find that during this period there have been no cases recorded as suspicious. However, bearing in mind the fact that typical and mild cases of the disease may have escaped recognition, and may be mistaken for malaria (Guiteras), I have analysed the cases of malaria occurring during this period.

Out of 127 cases of malaria, 21 had albuminuria. Out of these 21, in 10 the albuminuria cannot be satisfactorily accounted for by the temperature or other causes; in 9 out of the 10 it did not reach 103°. (The case in which it exceeds 103° is No. 7.) I append (Table 3) a list of these 10 cases, showing their salient features. All of them recovered. In two only is there a record of blood examination. There are no notes in regard to any possible pre-existing albuminuria. Four are officials, six are non-officials.

In Case 7 only is there a record of pulse-rate subsequently to admission, and I have cited it separately (it also appears in Table 3 to avoid confusion), as it appears to present some specially significant features.

It will be seen (i) that of the ten cases, six are seamen, notoriously careless livers ashore; (ii) that the specific gravity of the urine quoted in all but one instance is such as to discount the probability of the existence of renal disease.

It seems to me that in all these the presence of an albuminuria is difficult to explain, otherwise than on the supposition that they were really mild yellow fever. It is, of course, possible that the albuminuria, at any rate in a certain proportion of the cases, may have been due to a high pyrexia before admission to hospital. This possibility may, however, be excluded in the case of the four officials, who would call for medical attention immediately on being taken ill.

As a matter of interest it may be remarked that two of the cases came to Lagos from Abeokuta on the day of their admission to hospital.

Case No. 7.—Seaman. (?) Age. Admitted to hospital December, 1912. First trip to the West Coast of Africa. Has been out one month. Does not take quinine.

There are no notes of the onset of the illness.

On admission.—Headache complained of. Urine: thick cloud of albumen. Temperature, 103·6°. Pulse, 104.

Second day.—Maximum temperature, 104°.

Pulse, not recorded.

Headache continues.

Urine, 19 ounces.

Third day.—Maximum temperature, 102·9°.

Pulse, 88.

Urine, 17 ounces. Albumen in large amount.

Face flushed, eyes red, conjunctivae yellowish. Has vomited once after quinine; no blood in the vomit.

Patient says he feels worse, but is apparently better.

Fourth day.—Maximum temperature, 101·6°.

Pulse, 72.

Fifth day.—Maximum temperature, 100·4°.

Pulse, not recorded.

Albumen gone.

No jaundice.

6th, 7th, 8th, 9th day.—Uneventful recovery.

Blood, no parasites found.

The patient received five grains quinine three times a day throughout the illness. There are no notes of the state of the tongue.

In addition to these cases which were treated in Lagos Hospital, there is a record of an autopsy on a man who died on board a steamship in Lagos Roads on 2nd December, 1912. As it appears to present some doubtful features, I quote the record in detail:

Male.

Age, 34.

Death occurred at 5 p.m. on board s.s. "Shonga" in Lagos Roads, December 2nd, 1912.

Post-mortem held at 1 p.m., December 3rd, 1912, in hospital mortuary 20 hours after death.

External appearances.—Body well nourished. Rigor mortis passing off. Putrefaction had commenced. Bullae on skin. Post-mortem lividity in dependent parts.

Abdomen.—Liver somewhat enlarged, soft, and congested. Stomach, thinning of walls at greater curvature. Mucosa congested. Stomach contents, dark-coloured fluid.

Spleen, enlarged and soft; almost diffluent. (Temperature of body at time of death was 110° F.)

Sections of spleen and liver taken and sent to Medical Research Institute for examination.*

Death certified as due to hyperpyrexia. "No doubt due to malarial fever."

J. D. Finlay,
Medical Officer.

* There is no record to be found—E. J. W.

The 'Shonga' did not carry a doctor.

There were no passengers.

The ship had called at numerous British West African ports, from none of which, however, had yellow fever been reported. She had also called at a Liberian port to embark a native crew. No cases of the disease had been reported from Liberia.

In order to complete this series of cases I cite the following. I would add that it was decided not to be a case of yellow fever after very careful deliberation. The ship, on which the patient was engineer, had come to Lagos from Hamburg on 19th January. The patient sailed with her.

The only intermediate port of call was in Liberia, to embark a native crew. Since her arrival the ship had plied solely between Lagos and Forcados and ships lying in Lagos Roads. There had been no sickness on board prior to the patient's illness, and subsequently also there was none, except in the case of one man who was admitted to Lagos Hospital, suffering from a typical attack of malarial fever, on 21st May, and discharged on the 2nd June, 1913. The patient was, of course, frequently ashore both at Lagos and Forcados.

In my report, No. 4, which will deal with the outbreak of the disease which occurred in the Central Province recently, I hope to enter more fully into the relation of ships to epidemics of yellow fever in Southern Nigeria, which appears to be suggested by some of the foregoing cases.

Sex: Male.
Age: 28 years.
Nationality: German.
Occupation: Engineer on s.s. "Gouverneur von Puttkammer."
Date of admission to hospital: 8th May, 1913.
Date of death: 9th May, 1913.
Diagnosis: Uraemia and malaria.

History: Patient had been ill three days with fever. Vomited after taking any drink. Bowels had been confined, but were opened by an aperient. No headache.

On admission.—Tongue coated. Bowels opened. Liver and spleen normal. No tenderness in epigastrium. Pulse 112. Heart sounds normal. Respirations 24. Temperature 103·4° F. Severe headache. Pupils widely dilated. Face puffy. Slight oedema over both legs. Urine, acid; s.g. 1030. Albumen, large quantity. Blood, young ring parasites; aestivo-autumnal. Mononuclear leucocytosis.

Course.—12 p.m. on day of admission. Temperature 104°. Vomited once. Urine contains albumen. Urine passed at 8 45 p.m.—4 ozs. *9th May*, 1913.—

Patient very restless and delirious. No sleep. No urine passed. Bowels opened. Watery motions. Vomiting very frequent—dark, acid-smelling liquid. Saline given intracellularly 250 c.c. 1.30 p.m.—Pilocarpine, grs. $\frac{1}{4}$. Pupils widely dilated. Delirium present. 2 p.m.—Uraemic convulsions began. Vomiting very troublesome—dark, acid-smelling liquid. 3.20 p.m.—Died.

Pulse and temperature were as follows:—

	8th May				9th May	
	12 noon	4 p.m.	8 p.m.	12 midnight	4 a.m.	8 a.m.
Temperature	104	104·8	103·8	104	102·8	102·8
Pulse	112	100	—	88	98	104

Treatment (specific).—Two intramuscular injections of quinine on the day of admission—·4 grms.

9th May.—Inj. pilocarpine, grs. $\frac{1}{4}$. Chloral hydrat. grs. 20, per rectum.

Note.—The patient is said on good authority to have been a chronic alcoholic subject.

Post-mortem Notes

Rigor mortis had not set in.

Body was extremely fat and well nourished.

There was no yellow staining of the skin or conjunctivae.

Thorax—Heart: Pericardium normal, contained some fluid. Heart flabby and large deposit of fat round it. Otherwise normal. Lungs: No pleural adhesions. No effusion. Congested, particularly at bases.

Abdomen—Liver: Pale in colour. On section was fatty, the cut surface being greasy. Stomach: Pale in colour. No external haemorrhages. Contained a small quantity of brown fluid with a urinous odour. The mucous membrane was not congested. No haemorrhages. Intestines: Normal in appearance. No external haemorrhages. There was no congestion of the mucous membrane; a brown faecal fluid was present in small amount. Kidneys: Both kidneys were enlarged and congested, the capsule stripped easily; no external haemorrhages were to be seen. On section the cortex appeared swollen and pale. The omentum was extremely fatty, and there was a large deposit of fat about the abdomen.

Extract from Report upon Pathological Specimens sent for Examination to Medical Research Institute, Yaba

The organs were, unfortunately, somewhat damaged by being forced into a jar with insufficient preserving fluid. In consequence, it is difficult to determine to what extent the appearance of sections is due to this cause, and to what extent to pathological changes.

The kidney was enlarged, its capsule adherent, and its surface showed injected stellate veins. The cortex was swollen and yellowish; the pyramids not markedly congested. The tubules distended, the epithelium granular; the tubules contained casts. Glomeruli, large. Capsule, thickened. Interstitial tissue somewhat increased.

The liver (small piece) was yellow in section; surface, smooth. Extensive and intense fatty degeneration.

The spleen was enlarged and pulpy. The capsule thickened, congested, and dotted with masses of yellowish pigment. (The spleen, however, was certainly insufficiently preserved as it had putrified.)

The stomach.—Several minute haemorrhages. Mucosa, catarrhal.

The appearances were hardly those one would expect to meet with in a case of acute nephritis, and, on the whole, were more suggestive of an acute fever. I suppose there was no suspicion of yellow fever?

J. W. Scott Macfie

Table No. 1

Number	Number of years residence in an endemic area other than West Africa	Period between residence in an endemic area and first coming to West Africa (Interval of residence in a non-endemic area)	Number of months in West Africa since last in Europe	Number of months in Abeokuta since last in Europe	Number of months in other parts of West Africa since last in Europe	Number of months in West Africa (not including leave) since first coming to West Africa
1. Government official ...	4	10 weeks	8½	8½	—	8½
2. " " ...	2	12 years	5	4	1	43
3. " " ...	12	11 "	11	11	—	95
4. Non-official	20	2 "	11	11	—	71
5. "	4	3 "	12	2	10	12
6. "	1	20 "	70	70	—	272

Table No. 2

Number	Number of months in West Africa since last in Europe	Number of months actually resident in Abeokuta since last in Europe	Number of months in other parts of West Africa since last in Europe	Total number of months resident in West Africa since first coming to West Africa (not including leave)
1. Government official... ...	8	8	—	20
2. " "	3½	3½	—	74
3. " "	6	6	—	29
4. " "	13	7	6	13
5. " "	2	2	—	15
6. " "	12	12	—	12
7. Non-official	7	7	—	103
8. "	4½	4½	—	42
9. "	4	4	—	44
10. "	7	7	—	26
11. "	5	3	2	62
12. "	5	4	1	5
13. "	14	6	8	63
14. "	29	14	15	29
15. "	26	15	11	26
16. "	20	20	—	156
17. "	13	3	10	13
18. "	2	2	—	213
19. "	2	2	—	156
20. "	4	4	—	89
21. "	19	16	3	111
22. "	40	40	—	166
23. "	5	5	—	228
24. "	6	5	1	80
25. "	18	1	17	57
26. "	9	8	1	9

Table No. 3

Number	Date	Age	Occupation	Temperature on admission to hospital	Pulse on admission to hospital	Highest Temperature attained	Number of days in hospital	Specific gravity of Urine	Parasites in Blood	Remarks
1 Official	January, 1912	34	Telegraph Department	99·4	92	100·0	5	1030	No record	History of low fever several days before admission. Condition of tongue not noted
2 Non-official	February, 1912	25	Trader (from Abeokuta)	98·8	50	99·5	13	1030	No record	Pronounced tenderness in epigastrium. Liver and spleen palpable. Condition of tongue not noted
3* Non-official	February, 1912	28	Seaman	101·4	90	104·0 (On second day.)	5	1020	No record	Condition of tongue not noted
4 Official	July, 1912	24	Engineer (from Abeokuta)	101·8	72	101·8	13	1015	No parasites found	Spleen palpable. Widal negative. Temperature not reduced by quinine. Tongue furred on admission
5* Non-official	November, 1912	40	Seaman	100·6	84	101·6	5	1025	No record	Condition of tongue not noted
6* Official	December, 1912	34	Seaman	102·4	120	102·4	5	No record	No record	Condition of tongue not noted
7* Non-official	December, 1912	?	Seaman	103·6	104	104·0	9	1025	No parasites found	Notes of case on p. 8
8 Non-official	December, 1912	24	Trader	102·4	104	102·9	5	1030	No record	Said on admission that he had been vomiting for ten days. Condition of tongue not noted. Spleen four inches below costal margin
9 Official	March, 1913	33	Seaman	100·8	88	102·9	6	1025	No record	Tongue coated on admission
10* Non-official	March, 1913	41	Seaman	99·6	92	99·6	2	1019	No record	Tongue coated on admission

* For further notes on these cases see Report No. 4, Section III, pages 158, 159, 160, 161, 163.

IX. *Conditions as regards* Stegomyia *in Abeokuta and other places visited by patient, especially near residence of, and places frequented by, patient*

The conditions throughout Abeokuta are very favourable to breeding of *Stegomyia.* Water is obtained from wells by the natives (only those living in that part of the town which is nearest the river use river water), and is carried and stored in uncovered earthenware pots varying in capacity from one to eight gallons. (The manufacture of these pots is an important local industry.) Practically every compound contains large numbers of these vessels; in one selected at random in which ten persons lived there were thirty-three.

Some of these pots are sunk in the ground (often nearly to the brim) and are therefore never completely emptied. Moreover all wells (except three) are privately owned, and a charge, varying with season, is made for water. Hence it is to the financial interest of the native to economise water and to empty his water pot as slowly as possible. In one compound, for example, there were twelve pots, eleven of which contained larvae. In three compounds chosen at random there were fifty-two pots; thirty-five of these contained larvae, largely *Stegomyia*, nine were dry, and eight contained water without larvae. These compounds were within 200 yards of the patient's house.

I have examined forty compounds in widely separated parts of the town and have found larvae in all of them without exception. *Stegomyia fasciata* are present in considerable numbers, and form a large proportion of all larvae. This I have ascertained by actual hatching out. I have examined a number of water-tanks (filled by rain from the roof) attached to European dwellings, and found larvae in most of them (88 per cent.).

In most cases no serious attempt at mosquito proofing has been made. In others the proofing has been allowed to fall into disrepair. In the deceased's house, which stands in a thickly populated part of the town and is surrounded by native dwellings, the nearest European house being over half-a-mile distant, I found a cooler (a native earthenware vessel containing water, which, by evaporation of water through its walls, cools syphons, &c.,

immersed therein) in which *Stegomyia* larvae were numerous. This was an experience which I repeated in other European houses.

These water pots, whether in the houses of careless Europeans or in native compounds and houses, are the chief source of *Stegomyia* breeding during the dry season. The tins, broken bottles, and vessels of all kinds which are thrown down at random and apparently never cleared away doubtless form ideal breeding places in the wet season, lying free from disturbance among the rank grass and bush that abounds throughout the town.

There had been very little rain in Abeokuta up to the time of my investigations there, and I did not find larvae elsewhere than in the earthenware pots mentioned, in water-butts, and in one tin in which water had been placed.

Except in some of the better class native houses there are no latrines for natives in this town of 51,255 inhabitants (official census, 1911), the patches of uncleared bush and grass being used for this purpose.

One such patch, with the usual accretion of tins, bottles, &c., I found situated within a few *feet* of the patient's house.

The sanitary conditions generally which obtain in Abeokuta may, without over-statement, be described as deplorable, and as being calculated to foster not only yellow fever, but also enteric disease and (as has already been demonstrated) small-pox.

I have elsewhere mentioned that the native houses, though roofed with corrugated iron, are almost invariably devoid of gutters, so that this source of water-stagnation is not significant. I examined seventeen wells and nine ponds in widely distant parts of the town, but did not find *Stegomyia* larvae in any of them. The water was very low at the time in consequence of the retardation of the rains.

X. *Any recent movements of population suggesting possible introduction of virus*

(A) *Possibility of the introduction of the disease into Abeokuta by railway from Lagos.*—The average number of natives travelling per day between Abeokuta and Iddo (the railway terminus for Lagos) during March, April, and May, 1913, was 110. These

passengers generally carry with them as much impedimenta as the railway regulations allow. The journey from Lagos to Abeokuta occupies between three and four hours.

The virus might, therefore, very well be spread along this route by actual transport of infective cases, and, perhaps, also by transport of infective mosquitoes. No suspicious cases or suspicious high mortality have occurred in the country between Iddo and Abeokuta, through which the railroad passes.

(B) *Possibility of introduction of the disease into Abeokuta* viâ *the Dahomey-Nigeria boundary.*—Considering that the conditions affecting this possibility could be most satisfactorily investigated on the spot, I traversed the Abeokuta-Meko road and the road which runs southward from Meko to the sea, visiting all the villages and towns of importance near the boundary. Mr. Burrows, Comptroller of Customs, very kindly put at my disposal the services of Mr. Messer, Supervisor of Customs on the French boundary. This gentleman met me at Meko and accompanied me throughout the remainder of my journey, and, through his intimate knowledge of all the local conditions, was of the greatest assistance.

It also appeared to me that the distribution of *Stegomyia fasciata* might with advantage be investigated. In the map (facing page 24) the names of the places visited and inspected by me are encircled with red. Those in which *Stegomyia fasciata* were found are further marked with a cross. It will be seen that of the twenty-seven places visited *Stegomyia fasciata* were found in nineteen. It is, of course, possible that they are present in the towns and villages in which I failed to find them. My search was necessarily a somewhat superficial one. The method I adopted was to divide the town roughly into four quarters and to collect larvae from several widely-separated compounds in each quarter. And whenever possible larvae were obtained from pots within the houses rather than in the compounds.

The Medical Officer at Badagri informed me that *Stegomyia fasciata* are present in Badagri Town and in Aiyetoro. In the latter place I had failed to find them. He also informed me that he had found them in Iboro, Igbogila, and Yewa Metta—towns which were not visited by me.

The following is a list of the towns and villages I inspected. A cross after the name indicates presence of *Stegomyia fasciata* :—

Abeokuta. +	Ilaro. +
Lala.	Idawgaw (Dogo). +
Idi Emmi. +	Oke-Odan. +
Aiyetoro. +	Ajilete. +
Meko. +	Ado. +
Idofa. +	Ipokia. +
Tobolo.	Agoshasha. +
Aworro.	Battefin. +
Ijale.	Idi-iroko. +
Ijuwon.	Akolagi. +
Tata.	Ilashe. +
Egua. +	Joffin. +
Agbon.	Badagri. +
Iselu.	

It appears to me that this distribution of *Stegomyia fasciata* is a significant one in regard to the possible introduction of the disease from Dahomey, since the arrival of an infected person in a *Stegomyia*-infested area might easily convert such an area into a propagating centre for the disease. And it will be seen from the map that the most important towns, and therefore those which would most naturally be selected by a trader as a stopping place, harbour this insect.

As the result of my enquiries on the spot, I find that there is a constant traffic between Dahomey and Abeokuta, and that it goes by very various routes, and that the traffic between Porto Novo and Abeokuta does not go, except for short stretches, by the road known as the 'boundary road' leading through Joffin, Idi-iroko, Ilashe, Iselu, Egua, Ijuwon, Ijale, Aworro, Idofa, and Meko. The following are examples of the routes followed from French territory to Abeokuta :—

(i) The trade *viâ* Idofa and Meko is mostly from Ketu (in Dahomey) and neighbouring villages. and consists largely of seed cotton and palm kernels. (Whilst camped at Idofa I saw several natives passing through from Ketu, some being bound for Meko, others for Abeokuta.)

(ii) At Tobolo I was informed by the village headman that traders constantly pass through *en route* for Abeokuta, travelling from Ketu and proceeding *viâ* Aiyetoro.

(iii) At Ijuwon a large number of people pass carrying snails to the Abeokuta market from Porto Novo. This is a fairly regular trade. They first travel inland by the French railway and then cross the border at Ijuwon.

(iv) At Egua the village headman informed me that there is a considerable through traffic from Dahomey to Abeokuta.

(v) At Iselu I was similarly informed, and Mr. Messer tells me that he has many times seen people in this village *en route* from Porto Novo to Abeokuta. Such people mostly come up by rail as far as possible and then cross over the boundary.

(vi) At Ilaro there is a considerable trade in dried fish, which is brought from Porto Novo (the centre of the dried fish trade) *viâ* Ilashe and Oke-Odan, and carried on to Abeokuta.

(vii) At Idawgaw (Dogo) there is a similar trade in dried fish, the natives carrying it through to the markets at Ilaro, Aiyetoro, and Abeokuta, and bringing it from Porto Novo.

(viii) At Ipokia I saw dried fish in the market place which had been carried from Porto Novo. I also saw a native trader here who had come from Abeokuta, selling cloth, and was bound for Badagri. He informed me that there were others engaged in this trade between Abeokuta and Badagri. (Badagri is approximately seven hours by canoe from Porto Novo.)

(ix) At Joffin there is a considerable through traffic from Dahomey, some of which goes to Abeokuta, usually *viâ* Oke-Odan and Ilaro.

(x) There is also a canoe traffic from Porto Novo to Badagri and to Lagos (where passengers proceed by railway to Abeokuta). The average number of market canoes per month passing from Porto Novo to Lagos is twelve. The average number of passengers in each canoe is forty-five.

Hence it will be seen that movements of population affecting Abeokuta, as instanced above in paragraphs (A) and (B), are considerable, and imply wide possibilities of the introduction of disease.

I would here add that the direct journey from Porto Novo to Meko by road occupies five to six days, and from Meko to Abeokuta two to three days.

In addition to routes such as those indicated in paragraph (B) there are many minor footpaths and hunters' tracks leading across the boundary as well as water-crossings on the Ajara Creek and Iguidi River, and these minor ways are largely used by smugglers, of whose trade, chiefly in Dane guns, powder, and spirits, the Egba (Abeokuta) traders appear always to have made a speciality.

As I had been informed by the District Commissioner when in Abeokuta that a proportion of the trade between Porto Novo and that town is carried on by Haussas, who have a settlement of some size in Abeokuta, I had visited this settlement and interrogated some of them. They denied that there had been any cases of sickness or death among their people for 'many months.'

I made careful enquiries in all the towns and villages I visited as to the past and present health of the populace, but with the exception of one town I elicited no fact bearing upon this investigation. The exception was Ilaro, a town of some size in the Badagri District. It has no European inhabitants. The Church Missionary Society's native teacher informed me that for three months (May, June and July) there had been a rather exceptional number of deaths among children, most of whom appeared to suffer from the same symptoms. He had lost one of his own children a few days before my arrival. He said that all the fatal cases are about three years of age; that they die within nine days of onset of the disease; that the symptoms commence with 'fever,' then there is 'stomach burning' (? colic), then 'the white part of the eye becomes yellow,' and if death is going to ensue the 'black part' (? pupil or iris) becomes 'red.' There is anorexia. There is no vomiting, and a normal quantity of urine is voided. The bowels are, as a rule, open, the motions being neither black nor yellow, but intermediate between the two, in colour. They do not contain blood. Several natives corroborated the man's description and statement.

I remained in Ilaro for several days in the hope of seeing some of these cases, making house to house inspections, and instructing the local vaccinator and the native teacher to enquire for cases

throughout the town. I also interviewed the chief, and invited his co-operation in persuading his subjects to consult me. But the bush-natives' prejudice against European medicine when practised by a newcomer proved too strong. Only two sick children were brought to me, both of whom proved to be suffering from malaria, and several instances were brought to my notice of sick people having been actually removed from the town to distant farms on the arrival of 'the white doctor.'

I, however, saw one woman whose case (Appendix 3) is of special interest. Her case incidentally illustrates the difficulty of medical investigation among the natives in the 'bush.' When I first saw her in her hut, I brought away with me to my tent some of her urine to test. On the following day I despatched my interpreter with a message to the effect that a further sample was to be sent in a bottle in the course of the day. The bottle duly arrived, and was found to contain some *plain water*. I then visited her with my interpreter, and (as her action might have been prompted by fear) explained there was nothing at all to fear from the white man (an announcement that had already been made to the people by the chief through the medium of the town crier). She expressed her contrition for sending me plain water, and for trying to deceive, and emphatically denied being in the very least afraid of me. I expressed my satisfaction, and we parted on the most friendly terms, and with her assurance that she would send me some of her urine as soon as possible. In due course another bottle arrived, this time containing urine which proved, on testing, to be *normal*. Now, on the previous day it had been highly albuminous. My interpreter was accordingly despatched with instructions to supervise the act of micturition as closely as the etiquette of Ilaro society would permit, and only thus was I enabled to obtain a genuine sample.

(C) Since, on the assumption of the endemicity of yellow fever in Southern Nigeria, it is possible for the disease to have been introduced into Abeokuta (if not actually endemic there also) from unknown sources within the Colony, I complete this account of important routes into the town with the one leading eastward *viâ* the town of Asha. This is used, I am informed, by those travelling by road between Abeokuta and Ibadan (distance approximately 60

miles). There is, of course, also the railway route which extends northward viâ Ibadan into Northern Nigeria.

XI. *Disturbance of soil*

As in the history of some past epidemics of yellow fever the outbreak has apparently coincided with extensive disturbance of soil, I would here mention that up to the 10th May about $2\frac{3}{4}$ miles of trenches had been dug in Abeokuta for the reception of water-pipes. The house occupied by the European mentioned on page 1 was distant half a mile, and the house in which the native (Appendix 2) lived, was situated a quarter of a mile from the nearest point of disturbance. I would add that there were no collections of stagnant water in the excavations.

XII. *Conclusion*

The case about which this investigation centres is of particular interest and importance in that it occurred as an isolated instance of the disease in a European in a large native town (one of the largest on the African Continent) under, in some respects, very clear and unambiguous circumstances.

I have thought it desirable to summarise these circumstances with special reference to the observations by Sir James Fowler on yellow fever in West Africa, which have lately been circularised to Medical Officers in the Colony.

(The numbered paragraphs are those of Sir James Fowler's observations.)

1. The view of the endemic character of yellow fever in West Africa, which is now generally associated with the name of the late Sir Rubert Boyce, although he did not originate it, is accepted, i.e., the natives, rendered immune by infection, are the reservoir of the virus.

The patient left Abeokuta for Lagos on the afternoon of the 10th May. At 10 o'clock on the same evening the disease began to declare itself. Therefore, since he had not been away from Abeokuta for three months previously, he must have become infected in that town.

Since there had been no suspicious cases of disease among the

non-natives in Abeokuta, it follows that the insect which infected him received its virus from a native. (Conceding that the cases of the two seamen—9 and 10, Table 3—admitted to Lagos Hospital on the 9th and 15th March were mild cases of yellow fever, it would be a very remote possibility that they were the source of the patient's infection.)

2. It has been proved by experiment that the manifestations of this disease vary greatly in intensity; in practice the severe form is comparatively easily recognized, the milder form only with great difficulty.

The native cases in Appendices 1, 2 and 3, and the European cases in Table 3, perhaps illustrate this variation in intensity.

From a limited experience of the disease I hesitate to venture upon a positive assertion, but I would remark that the cases I have had the opportunity of observing since the commencement of the epidemic in Lagos seem to demonstrate that the salient feature, at any rate as far as natives are concerned, is the presence of an otherwise unexplained albuminuria, and it seems to me that it is only in the absence of such an albuminuria, which is said to occur in mild cases (*Touatre*), that the diagnosis can be in doubt.

3. The intervals between the occurrence of well-marked cases are often considerable, but the attempts to prove that recent epidemics and cases have been due to the introduction of the virus from without (e.g., by an infected ship) have so far failed.

No case of yellow fever has ever been reported from Abeokuta before the occurrence of the one under consideration. The possibility of the introduction of the disease into that town *viâ* Lagos from an infected port outside the Colony (e.g., from Accra, which was in quarantine from 15th March to 10th April, or from Grand Popo (Dahomey), which was in quarantine from 18th February to 12th March) is very remote.

4. If it comes from the hinterland, or is brought overland from neighbouring foreign colonies, it is still endemic, though possibly not amongst our people.

As shown in section X, there is a free communication across the Dahomey-Nigeria boundary, but I have obtained no evidence that the infection was introduced from the French Colony. Infective fevers, when introduced into non-immune communities, quickly

declare themselves in epidemic form, and there appears to be no reason why yellow fever (making due consideration for the characteristic cycle of the organism as far as it is known) should be regarded as exceptional in this respect. The fact of no *known* epidemic of the disease having occurred among the natives in Abeokuta as a sequel to this case suggests that (i) either the native has a partial natural immunity, so that he acquires the disease only in a modified form, (ii) or that he has acquired immunity. In either case the disease must be endemic.

5. Epidemics in the past have often commenced in seaport towns and have spread inland; rarely from inland towards the coast.

I would suggest that this is due to the fact that Europeans are congregated mostly in seaport towns, and that it is, therefore, in these towns that the virus has most opportunity for exaltation. The patient, as shown in section IV, had indifferent health prior to his attack by a virus which, in a person of normal resistance, might have produced only a mild and, perhaps, unrecognised manifestation of the disease.

6. Assuming that in some such case it has not spread from an infected ship, non-immune sailors have been first attacked because they live carelessly when on shore.

The patient's case does not elucidate this aspect of the matter.

But it is of interest to note that of the ten cases in Table 3 six are seamen.

7. Recently arrived Syrians, who are now often the first to be attacked, are the non-immune Europeans who live in closest contact with the natives.

The one Syrian trader in Abeokuta had been resident six years. He has since contracted the disease—nearly three months after the European case from the town.

8. After many epidemics of yellow fever, as of other diseases, it has been remembered that the severe cases were preceded by mild cases, the nature of which was not at the time recognized, but which, judged by subsequent experience, were probably examples of the same disease.

The case described in Appendix 1 was recognized only because a special vigilance was being exercised. It may well be that many

other similar undetected cases occurred among natives, not only after, but also antecedent to, the European case.

9. In these mild cases the virus was gaining in intensity by transmission through one or more non-immunes, either Europeans or natives, and when increased virulence had thus been gained infection of a non-immune was followed by a typical attack of the disease.

As already stated, the patient had indifferent health prior to his attack by a virus which, in a person of normal resistance, might have produced only a mild and, perhaps, unrecognized manifestation of the disease. If, however, the virus underwent a process of exaltation before infecting him, it must have done so through non-immune natives.

10. If this is true, an outbreak of yellow fever should be preceded by mild attacks of fever, *proved not to be due to malaria*, occurring in non-immune Europeans or natives, and presenting symptoms suggestive of yellow fever, such as have been shown to follow the experimental transmission of the disease.

See remarks under paragraph 8.

11. The direction, therefore, to search for evidence of fevers occurring or having occurred in natives, and especially in native children, shortly before an epidemic of yellow fever requires to be supplemented by a similar direction as regards non-immunes, whether native or European.

As stated in section VIII, no suspicious cases had been noted in Abeokuta previously to the patient's illness.

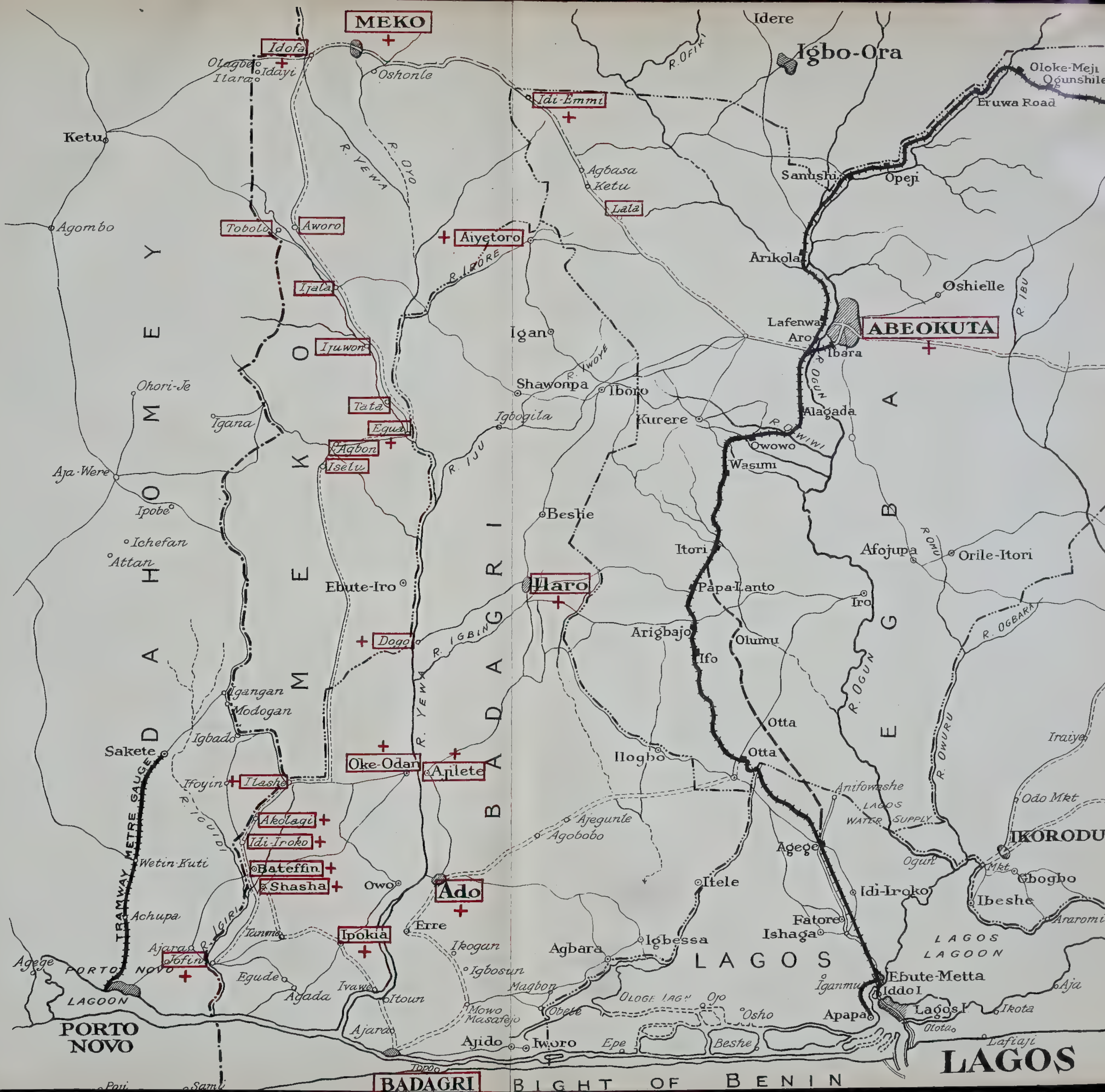
Conceding that Cases 9 and 10 (Table 3) are instances of mild yellow fever in Lagos, actual transmission to Abeokuta of an insect infected from them, or transmission of infection *viâ* a native, has to be supposed.

12. Special enquiry be made to ascertain if natives regard certain illnesses as almost belonging to early life as what we call 'childish ailments.' The 'childish ailments' of a people represent its endemic diseases.

I have been able to gain no information on the subject of such 'childish ailments,' except the description given me at Ilaro set out in section X.

E. J. W.

22nd August, 1913.



MEKO
Idofa
Olagbe
Idayi
Ilara
Oshonle
Idere
R. Ofiki
Igbo-Ora
Oloke-Meji
Ogunshile
Eruwa Road
Idi-Emmi
Ketu
R. Yewa
R. Oyo
Agbasa
Ketu
Lala
Sanushi
Opeji
Agombo
Tobolo
Aworo
Aiyetoro
R. Ijore
Arikola
Oshielle
R. Ibu
Ijala
Lafenwa
Aro
ABEOKUTA
Ibara
Ijuwon
Igan
R. Iwoye
Shawonpa
Iboro
Ohori-Je
Tata
Igana
Egua
Igbogila
Kurere
Alagada
R. Ogun
R. Wiwi
Owowo
Agbon
Iselu
R. Iju
Wasimi
Aja-Were
Ipobe
Beshe
Ichefan
Attan
Itori
Afojupa
R. Omu
Orile-Itori
Ebute-Iro
Ilaro
Papa-Lanto
Iro
DAHOMEY
MEKO
BADAGRI
EGBA
Dogo
R. Igbin
Arigbajo
Olumu
Ifo
R. Ogbara
R. Ogun
Igangan
Modogan
R. Yewa
Otta
Iraiye
R. Owuru
Sakete
Igbado
Oke-Odan
Ajilete
Ilogbo
Otta
TRAMWAY METRE GAUGE
Ifoyin
Ilashe
R. Iouidi
Anifowoshe
Lagos Water Supply
Odo Mkt
Akolagi
Idi-Iroko
Ajegunle
Agobobo
IKORODU
Wetin-Kuti
Bateffin
Shasha
Owo
Ado
Itele
Agege
Ogun
Mkt
Gbogbo
Idi-Iroko
Ibeshe
Achupa
Igiri
Tanmo
Erre
Ipokia
Fatore
Aramomi
Ishaga
Igbessa
Agbara
LAGOS
Lagos Lagoon
Ajara
Jofin
Ikogun
Agege
PORTO NOVO
LAGOON
Egude
Igbosun
Magbon
Ologe Lagoon
Ojo
Iganmu
Ebute-Metta
Iddo I.
Aja
Agada
Ivawo
Itoun
Mowo
Masafejo
Obele
Osho
Apapa
Lagos I.
Ikota
PORTO NOVO
Ajara
Ajido
Iworo
Epe
Beshe
Olota
Lafiaji
LAGOS
Topo
Poji
Sami
BADAGRI
BIGHT OF BENIN

Appendix I.

The patient was a well-nourished boy aged 12 years. When first seen by the Father Superior (Catholic Mission) he complained of severe frontal headache, malaise, and anorexia. He denied any dietary indiscretion. Temperature, 100° F. Tongue clean. No anaemia. No splenic enlargement. No albuminuria. He was given four grains of quinine and a saline purge.

Evening of the 2nd day :
Temperature, normal.
Albumen (a cloud) present.
Tongue furred, but edges and tip clean.
Patient complained of languor.
The Father Superior gave him a saline purge and communicated with me.

Third day.—Seen by me :
Patient did not look ill, but complained of feeling tired.
Temperature, normal.
Pulse, 96.
Chest and abdomen, normal. No epigastric tenderness.
No splenic enlargement.
Tongue, dorsum coated, edges and tip clean.
Throat, normal.
Ears, normal.
Eyes, not jaundiced.
Urine : acid, sp. gravity 1020. No casts. A cloud of albumen.
He has not had any vomiting or abdominal discomfort.
He has no pains in the limbs or body.

Fourth day.—No change.

Fifth day.—Feels quite well. Urine now free of albumen ; specific gravity 1022. No jaundice. Tongue very slightly furred. Pulse 96. Temperature, normal.

Blood examination on 3rd day of illness :
Polymorphonuclears, 59½ per cent.
Large mononuclears, 10½ per cent.
Small mononuclears, 17½ per cent.
Eosinophils, 12½ per cent.

No parasites found.

As helminthiasis of one kind or another is exceedingly common among the natives, the eosinophilia may reasonably be attributed to this cause.

Commentary

While in charge of native out-patients at Lagos Hospital, before undertaking the present investigation, I encountered several cases of mild pyrexia complaining of slight symptoms such as frontal headache, nausea, &c., in whose urine I found a little albumen, and whom I admitted to hospital.

Dr. Leonard, the Resident Medical Officer, who has charge of

in-patients (and whom I have to thank for several useful suggestions regarding the course of my investigation), has forwarded the details of these cases.*

In view of their anomalous character and of their possibly infective nature we thought it very desirable that they should be carefully recorded, and it is for a similar reason that I am sending the record of this one.

It seems to me that the slight pyrexia, together with the character of the tongue, and the development of albuminuria on the second day, are very suggestive features.

I was unable, either at the time of his illness or subsequently, to discover any other cases of similar nature in or around the patient's residence.

Appendix 2

(i) Copy of post-mortem notes, and (ii) notes of the case of a native of Igbere (Igbere is one of the districts into which the town of Abeokuta is divided); (iii) commentary. The information upon which the notes of the case are based was obtained by me from the deceased's uncle, with whom he lived.

(i) *Copy of post-mortem notes by the then Medical Officer, Aro, Dr. A. E. Neale.*

Post-mortem examination of a male native at Aro mortuary, 23*rd May*, 1913.

The body was that of a native boy apparently about the age of 15 years.
There were no marks of injury on any part of the body.
The eyeballs were prominent and jaundiced.
On dissection I found the—

Heart: healthy—full of blood clot.
Lungs: showed hæmorrhage into the right lower lobe.
Chest cavity contained blood clots.
Stomach: inflamed and containing round worms and blackish liquid—not gritty. On further examination this proved to have elements of disorganised blood.
Liver: Very large and yellow—bile-stained throughout.
Spleen: Very black, normal in size.
Kidneys: haemorrhagic.
Intestines: inflamed.
Brain: much congested at the base, with small blood clots.
There seemed to be slight appearances of fracture of the base of the skull, but no fracture could be found.

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* Vide report on Certain Outbreaks of Yellow Fever by Dr. T. M. R. Leonard, pages 207-316.

(ii) *Notes of the Case*

Deceased was a butcher by trade. He became ill on the day preceding death. On returning home from work he complained of feeling ill, and of having been beaten. He said he had 'pains in the body.' His eyes were noticeably 'red.' He did not, however, look as if he had been beaten, and there were no marks. He 'had fever.' His 'skin was hot.' He vomited once, after partaking of some agidi (native food). He complained of 'headache over the whole head.'

He had not been away from Abeokuta for at least six months before his death. I have been unable to discover any cases of illness or death in the neighbourhood of the house in which he died.

There were numerous water-pots with *Stegomyia* larvae in his and the surrounding compounds.

(iii) *Commentary*

The house in which this boy died is approximately 300 yards from the house occupied by the European mentioned above.

The European left Abeokuta on the 10th May.

The native was taken ill on the 22nd May.

The European case may have been infective to the mosquito on the night of the 9th May, or even earlier.

The period 9th to 22nd May is of just sufficient length to allow the transmission of the disease under normal limits from one person to another *viâ* a hitherto uninfected mosquito.

In the particular case under consideration (assuming it to have been one of yellow fever), the short incubation period (one day, allowing twelve days in the mosquito) and quickly fatal termination in the native might be explained on the assumption that the virulence of the infecting organism was exalted in its passage through the non-immune European host. But, if that were so, one would have expected other cases to develop. These *may*, of course, have occurred and remained undiscovered. I have already had occasion to note the reticence of natives in imparting information.

Appendix 3.

The patient was a woman aged about 20 years.

The illness had begun with frontal headache and vomiting after food.

When first seen she had been ill six days; there was no headache, but she felt, and looked, very ill.

Temperature normal.

Pulse 80.

No jaundice.

Tongue clean.

Spleen not enlarged.
Bowels open normally.
No frequency of micturition.
No oedema. Heart and lungs normal.
Urine: Thick cloud of albumen and bile present.
On the following day:
Slight yellowish tinge of conjunctiva.
Urine: albumen less in amount; no bile.
General condition better. No pyrexia.
Next day:
Conjunctival tinge of jaundice as before.
Urine: albumen lessening.
General condition much improved.

Commentary

The record of this case investigated in the 'bush' is necessarily incomplete. I have no doubt that it was not a case of renal disease or of malaria, and I quote it because it appears to come into line with the cases mentioned in my Commentary in Appendix 1.

APPENDIX 4

RECORD OF RAINFALL AT ABEOKUTA

	1911		1912		1913	
	Average Maximum Shade Temperature	Inches of Rain	Average Maximum Shade Temperature	Inches of Rain	Average Maximum Shade Temperature	Inches of Rain
March ...	No record	6·66	No record	0·70	98·8°	2·90
April ...	95°	8·65	99°	5·98	94·5°	4·09
May ...	93°	9·13	97°	3·40	92·3°	5·19

Appendix 5

Deaths at Lagos

	1910				1911				1912				1913			
	Total Deaths	Rate per 1,000 of Population	Deaths of Children under One Year	Rate per 1,000 of Population	Total Deaths	Rate per 1,000 of Population	Deaths of Children under One Year	Rate per 1,000 of Population	Total Deaths	Rate per 1,000 of Population	Deaths of Children under One Year	Rate per 1,000 of Population	Total Deaths	Rate per 1,000 of Population	Deaths of Children under One Year	Rate per 1,000 of Population
January ...	178	39·5	67	14·8	157	30·8	55	10·8	182	35·7	58	11·4	161	31·6	36	7·0
February ...	138	30·6	56	12·4	127	24·9	41	8·0	129	25·3	49	9·6	131	25·7	33	6·4
March ...	170	37·7	54	12·0	158	31·0	56	11·0	122	24·0	41	8·0	156	30·6	30	5·9
April ...	130	28·8	40	8·8	125	24·5	38	7·4	145	28·5	52	10·2	156	30·6	40	7·8
May ...	123	27·3	35	7·7	115	22·6	48	9·4	146	28·7	48	9·4	163	32·0	64	12·5
June ...	161	35·7	75	16·6	172	33·8	81	15·9	163	32·0	73	14·3	145	28·5	59	11·6

Report No. 2

A case of yellow fever was admitted to Lagos Hospital on Friday, 22nd August, 1913.

When passengers arriving by train were examined on that day, the patient, a male native aged 29 years, was found to be suffering from pyrexia (103° F.).

He was admitted to Lagos Hospital for observation, and the diagnosis of yellow fever was made on the following day.

I at once proceeded to Ogbomosho, where he had been staying for one month and whence he had travelled to Lagos *viâ* Oyo, Fiditi, and Ibadan, immediately preceding his detention.

I. *Actual movements of the patient for three months before illness*

The patient is a trader in cloth.

The following were his movements for the three months preceding his illness as nearly as I could ascertain:

He had travelled from Ogbomosho to Zaria (in Northern Nigeria) and back to Ogbomosho. He had then remained at Ogbomosho for one month. He then proceeded by road to Ibadan; the journey occupied three days. He slept at Oyo (a large town of about 45,000 inhabitants) and Fiditi (an exclusively native town—population about 3,000). He remained overnight at Ibadan (population about 175,000) and left on the following day by train for Lagos (about seven hours' journey). Was examined with the other passengers on arrival and sent to Lagos Hospital for observation.

II. *Prevalence at Ogbomosho and other places visited by patient of any suspicious cases of fever and any recent (suspicious) high mortality among natives at such places, especially native children*

Ogbomosho is a large and dirty town of about 80,000 inhabitants, situated on an extensive, lofty plateau, about 180 miles N.N.E. of Lagos and about 30 miles from the nearest railway station. Neither here nor at Oyo, Fiditi, and Ibadan, was I able

to ascertain the existence of any present or past suspicious cases of fever or of a suspicious high mortality among adults or children. Dr. Green, an American Baptist missionary and medical graduate, has resided at Ogbomosho continuously for two and a half years. He has a small hospital and dispensary, and being well known by, and thoroughly 'in touch' with, the inhabitants, would almost certainly have heard of such cases had they occurred. He accompanied me during my enquiries in Ogbomosho town, which extended over several days, and in the patient's compound, and, indeed, assisted me as much as possible in every way.

III. *Number of Europeans at Ogbomosho and other places visited by patient and suspicious cases of fever amongst them within the last twelve months*

Neither at Ogbomosho, Oyo, or Ibadan have there been any suspicious cases of fever among Europeans. There are no Europeans at Fiditi.

Their number in the places mentioned is as follows:

Ogbomosho, 3 (non-officials).

Oyo, 2 (officials); 10 (non-officials).

Ibadan, 20 (officials); 41 (non-officials).

It is scarcely possible that the patient could have acquired his infection in Ibadan (see paragraph VI). For the sake of completeness, however, I obtained the statistics relating to the town quoted above. I also examined the hospital case-books and *post-mortem* records, with negative result. I should mention that European officials at Oyo apply for medical treatment to the Medical Officer at Ibadan, by whom such cases are entered in the Ibadan case-books, and that non-officials are sometimes treated by the American Baptist missionary (who is also a medical graduate) at Oyo. I took occasion to interview him, and he informed me that no suspicious cases had come under his notice. The Europeans at Ogbomosho are inmates of Dr. Green's household.

IV. *Conditions as regards* Stegomyia *breeding in Ogbomosho and other places visited by patient, and near his residence*

I found from actual breeding out of larvae that *Stegomyia fasciata* is present in Ogbomosho, Oyo, Fiditi, and Ibadan.

The conditions in all these towns for *Stegomyia* breeding are favourable, there being numerous water-pots in the native compounds. Larvae are abundant.

S. fasciata larvae were numerous in the patient's compound at Ogbomosho.

V. *Movements of population suggesting possible introduction of virus.*

The Bale (Chief) of Ogbomosho informed me that there is a free interchange of trade through the town, and instanced as objectives: Northern Nigeria, Dahomey, Ibadan, Abeokuta, and Lagos. Infection might, therefore, easily be introduced into the town from without.

VI. *Conclusions*

I conclude that the patient must have acquired his infection either in Ogbomosho or in Oyo. He *might* have acquired it at Fiditi; but in that case the incubation period must have been fifty-four hours or less. It is scarcely possible that he became infected in Ibadan, since the number of hours between his arrival in that town and his detention at Lagos on the following afternoon would connote an incubation period of (at the most) thirty hours, and the number of hours between sunset on the day of his arrival in Ibadan and the time of his detention in Lagos would imply an even shorter incubation period (twenty-two hours). In spite of the fact, however, that infective *Stegomyia* bite only after sunset, this latter period of twenty-two hours seems here hardly to be of significance, for native houses are, as a rule, exceedingly dark, the interiors being in very many instances maintained in such a state of perpetual night that persons frequenting them would be liable to become infected at any period of the twenty-four hours.

These conclusions as to the locality in which the patient was infected are based on the supposition that the date of his admission to hospital coincided with the first day of his illness. When I questioned him in hospital he denied having any subjective symptoms, or having experienced any in the past few days, though I understand that when previously interrogated by

the Resident Medical Officer he gave the impression that he was, on admission, in the fifth day of the disease. In this latter case he must have acquired the disease in Ogbomosho. Statements of native patients regarding their health are, of course, frequently of doubtful value. Since in none of the towns visited by the patient within a month of the onset of his illness have there been any suspicious European cases, it appears to be clear that (excluding a hypothetical animal source of infection) the patient acquired the disease from another native.

E. J. W.

6th September, 1913.

Medical Report

Yellow Fever. Case No. 15 (*No. I from Ogbomosho*). L. 55

Sex: Male.
Age: 29 years.
Nationality: Yoruba.
Occupation: Trader.
Date of Admission: 22nd August, 1913.
Date of Discharge: 7th September, 1913.
Disease: Yellow fever.

History.—Patient was sent to the hospital by the Medical Officer, Ebute Metta, from off the evening train from Ibadan, as he was found to have a temperature of 103°. He was a passenger from Ogbomosho *viâ* Oyo and Ibadan; he had not been in Lagos for the past four to six weeks.

On Admission.—Patient had a temperature of 101·6°. Pulse, 66. Complained of a frontal headache and pains in the limbs. Conjunctivae were injected and red.

Alimentary System.—Tongue pointed and red. Gums red. Liver normal. Spleen normal. Bowels constipated. No vomiting, but nausea present.

Circulatory System.—Heart normal. Pulse, 66, low tension.

Respiratory System.—Lungs normal. Respirations, 24.

Nervous System.—Frontal headache and pains in the extremities and back.

Urinary System.—Urine examination: Acid reaction; sp. gr. 1030; albumen present.

Other Systems.—Conjunctivae injected and red.

Blood Examination.—A few malaria parasites seen. Pigmented leucocytes present. Leucopenia present.

8 p.m. Temperature, 101·2°. Pulse, 56.

23rd August:—

12 a.m. Temperature, 101°.
4 a.m. Temperature, 100·8°. Pulse, 52.

8 a.m. Temperature, 100°. Pulse, 52.
Patient had a fair night. Headache still complained of this morning.
Urine examination: Acid reaction; sp. gr. 1030; albumen present.

12 noon Temperature, 98·6°.

4 p.m. Temperature, 98·4°.

8 p.m. Temperature, 98·4°.

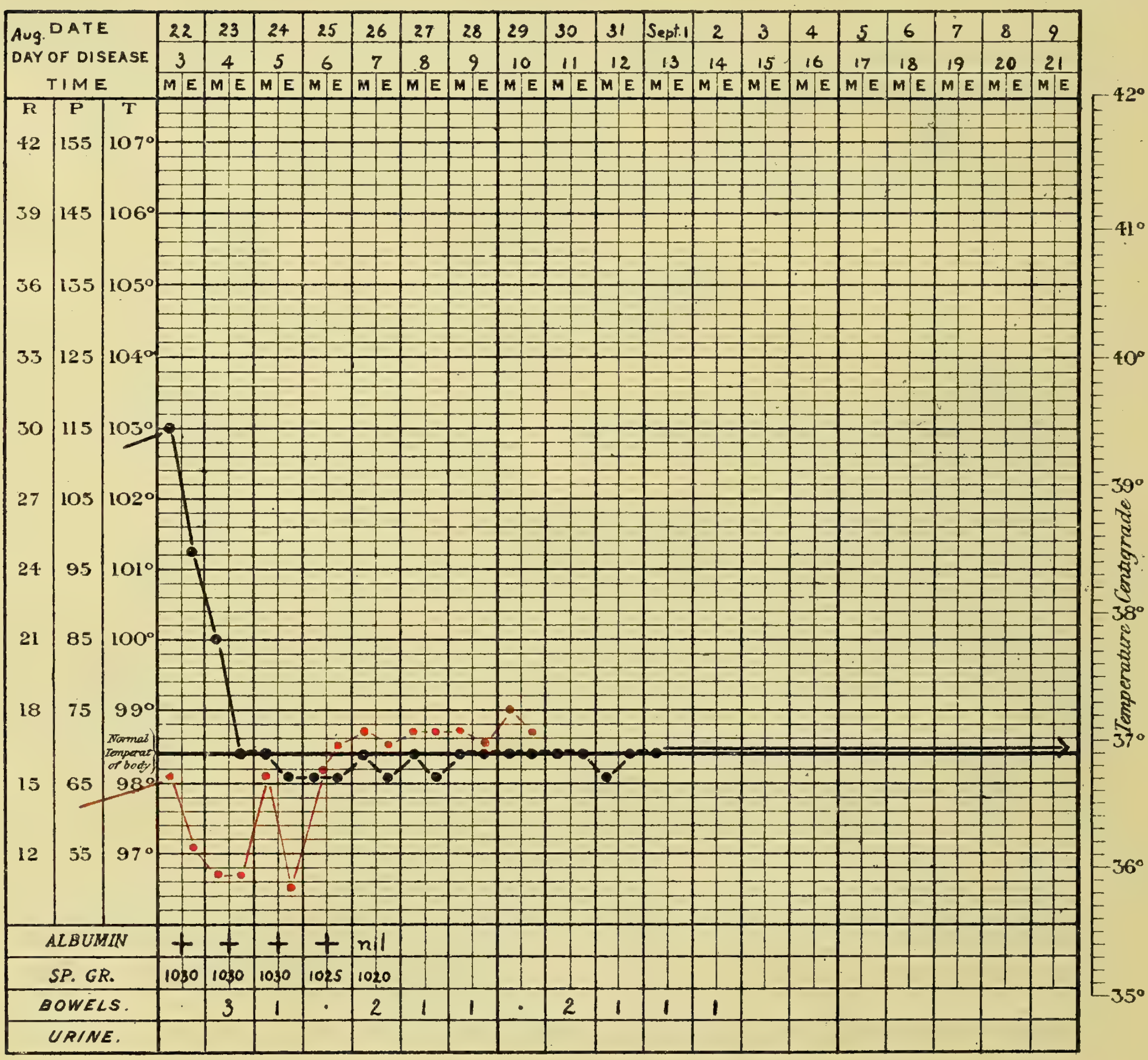


Chart I.

24th August:—

8 a.m. Temperature, 98·4°. Pulse, 66.
Patient had a good night. Feels very much better; headache only slight. Bowels opened.
Urine examination: Acid reaction; sp. gr. 1030; albumen present.

8 p.m. Temperature, 98·2°. Pulse, 50.

25th August :—

8 a.m. Temperature, 98·2°. Pulse, 66.
Patient had a good night. Slept well.
Urine examination : Acid reaction ; sp. gr. 1025 ; albumen present ; slight.

8 p.m. Temperature, 98·2°. Pulse, 70.

26th August :—

8 a.m. Temperature, 98·4°. Pulse, 72.
Patient had a good night, and is feeling well. Bowels opened.
Urine examination : Acid reaction ; sp. gr. 1020 ; no albumen ; bile present.
Sclerae quite yellow.

8 p.m. Temperature, 98·2°. Pulse, 70.

28th August :—

8 a.m. Temperature, 98·4°. Pulse, 72.
Patient is doing well. Appetite good. Bowels regular.
Urine normal ; no albumen.
Sclerae yellow.

8 p.m. Temperature, 98·4°. Pulse, 72.

Patient continued to do well, and was discharged cured on the 7th September, 1913.

This was one that had been undoubtedly infected in Ogbomosho and not in Lagos, the day of disease being about the third or fourth from the symptoms.

T. M. RUSSELL LEONARD,
Resident Medical Officer, Lagos Hospital.

Report No. 3

An investigation carried out at Abeokuta in connection with the case of a Syrian, and three cases in natives. The Syrian and one of the natives were admitted to the French Roman Catholic Mission Hospital; the other two received treatment as out-patients at the Mission.

I have, as on the occasion of sending in my first report, to acknowledge the valuable assistance rendered me in my investigation by the Reverend Father Superior, to whom I am also indebted for clinical notes on all the cases.

The Father Superior is not a medical man, and I have found it necessary to edit my translation of his notes to a certain extent.

Case of the Syrian Trader

The illness commenced on the 31st July.

He had not been away from Abeokuta for many months previously with the exception of:—

(i) A visit to Lagos about the end of April. He stayed there one night only. At that time no cases of the disease had been reported in Lagos.

(ii) A visit to Ibadan about the middle of June. Here also he stayed one night only.

As noted in the report of my investigation of the native case which came from Ogbomosho, I ascertained that no suspicious cases among Europeans or natives have occurred in Ibadan, and that there has been no suspicious high mortality there among native adults or children.

Nor does there appear to have been any recent suspicious high mortality among native adults or children in Abeokuta.

For cases that have occurred among natives in Abeokuta see under 'Remarks.'

No cases have occurred among Europeans in Abeokuta since that investigated in my first report.

As regards the patient's personal habits, he says he has 'not been inside two native houses' during the six years he has resided

in Abeokuta, and he is certain that he has not been inside one for at least two years. He informs me that he lives entirely alone, not even a servant sleeping in the house, but about two months before he was taken ill another Syrian trader came to stay with him, and remained for three months, being in good health throughout this time.

This man has since left. The luggage he brought consisted of a small hand-bag containing clothes. The patient's house is in a thickly-populated part of the town, and is surrounded by native houses and compounds, which are in no wise different from those described in my first report.

There are no other Syrians in Abeokuta.

The following is a clinical report of the case compiled from the notes made by the Reverend Father Coquard (who treated the patient) and by Dr. Clark.

Clinical History of the Case

31*st July*, 1913.—The patient, a Syrian trader, aged 26, was seized in the morning at 7 a.m. with shivering, severe frontal headache, violent pain in lumbar region and epigastrium.

He was first seen at 5 p.m. by the Father Superior.

The symptoms were then as above. Also :—

Face flushed.
Eyes injected.
Tongue slightly furred.
No vomiting.
Pulse ' rapid.'
Temperature 102·8° F.

Treatment.—Patient had taken a saline purge in the morning.
Injection of quinoform at 5 p.m.
Tinct. opii, m. 40, at 7 p.m.
Sips of effervescing Vichy water.

1*st August*, 1913.—7 a.m. Symptoms as yesterday, but epigastric pain almost gone and less headache.

Patient had a little sleep during the night.
4 p.m.—Epigastric pain has disappeared.
Treatment.—Sulphate of quinine in cachet.
Vichy water as before.

2*nd August*, 1913. 7 a.m.—Delirium. Yellow bilious vomit. Patient takes no nourishment and is very ' fatigued.'

Tongue furred.
7 p.m.—Condition unchanged.
Treatment.—Antipyrin.

3rd August, 1913.—Patient had no sleep last night.
'Brown' vomit.
Albumen present for the first time, and in large amount.
Haemorrhage from gums; also a few drops of blood after micturition.
Treatment.—Enules of meat and milk.
Saline per rectum.
Injection of quinine.
Chloroform water and solution of perchloride of iron 'for the haemorrhage.'

4th August, 1913. 7 a.m.—Condition generally unchanged.
Has taken a little pasteurised milk.
Treatment.—As before.
The patient asked for rice and was given a little rice-water.
7 p.m.—Patient says he feels better.

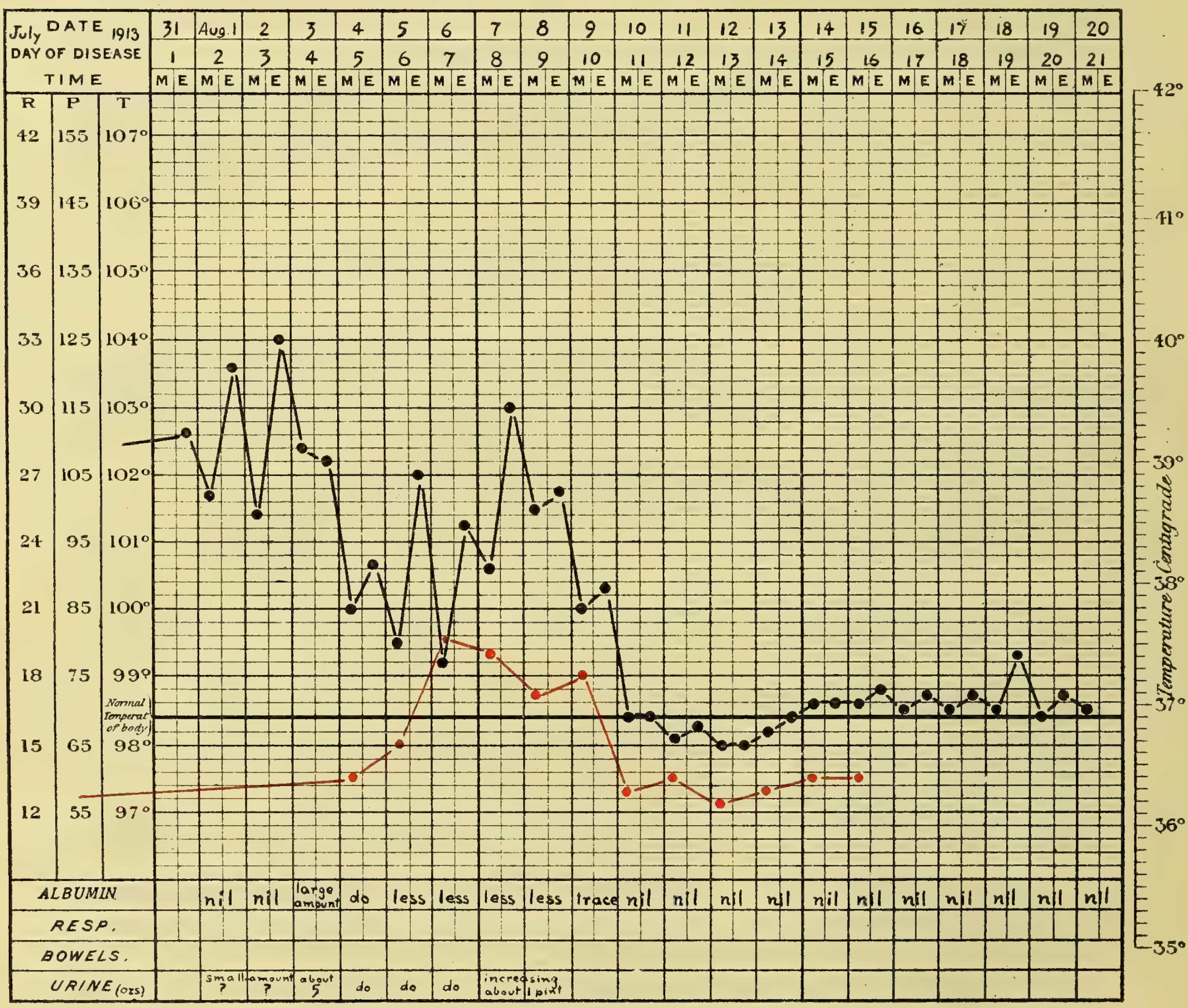


Chart 2.

5th August, 1913. 8 a.m.—Hitherto treated in his own home, patient was now admitted to Mission Hospital.
Conjunctivae jaundiced.
Vomiting has ceased, and the patient has taken a little milk.
Treatment as before.

6th August, 1913. 6 a.m.—Skin jaundiced.
Measles-like rash over face and body ; petechial in places.
Brownish vomit.
Treatment as before. Also iced champagne and soda.
7 p.m.—Patient says he feels better.

7th August, 1913. 7 a.m.—Haemorrhages ceased.
Treatment as before, with the exception that quinine is now given per os.
Saline per rectum is continued.
6 p.m. *Treatment.*—Patient able to retain soup and milk.
Quinine again given by injection.

8th August, 1913.—No further haemorrhages.
Treatment as before.

9th August, 1913.—Leucocytosis present.
General condition better.

10th August, 1913.—Temperature normal.
Albuminuria has ceased.
The patient made an uninterrupted recovery.

Cases of Three Natives

Case I :—

Sex : Male.
Age : 16 years.
Date of onset of illness : 10th August.
Date when first presented himself for treatment : 13th August.
Symptoms on 13th August :

Frontal headache.
Albuminuria.
Temperature }
Tongue } No record.
Pulse }
Jaundice }

Course.—Albuminuria disappeared on the 19th August.
No other record.
Treatment.—Saline purge. Quinine. Vichy water.

Case II :—

Sex : Female.
Age : 15 years.
Date of onset of illness : 1st July.
Date when first presented herself for treatment : 2nd July.
Symptoms on 2nd July :

Slight frontal headache.
Albuminuria.
Temperature, 100·2° F.
Tongue furred.
Pulse not noted.
No jaundice.
Patient is nauseated, but has not vomited.

Course.—Albuminuria disappeared about the 8th July.
No other record.
Treatment.—Saline purge. Quinine. Vichy water.

Case III :—

Sex : Female.
Age : 6 years.
Date of onset of illness : 6th August.
Date when first presented herself for treatment : 14th August.
Symptoms on 14th August :
 'Fever.'
 Albuminuria.
 Anorexia.
 Nausea, but no vomiting.
 Temperature, Tongue, Pulse, Jaundice — No records.

Course.—Albuminuria disappeared on 16th August.
Treatment.—Saline purge. Quinine. Vichy water.

Remarks

None of the patients had been in contact with the Syrian or with one another.

None of them had been away from Abeokuta for three months.

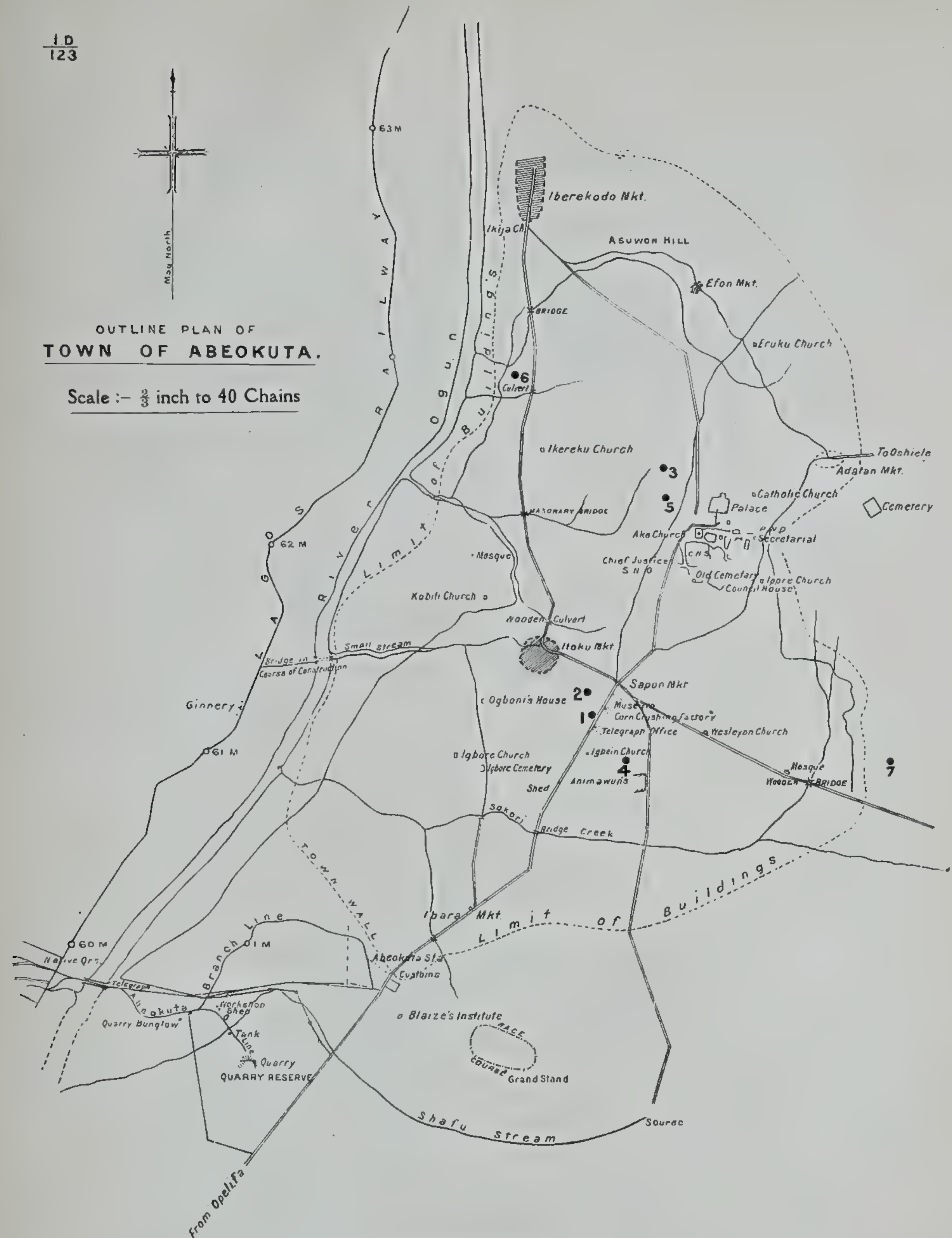
I found their compounds in the usual state of dirt and neglect. In that of Case II there were adult *S. fasciata* in a water pot.

I was unable to discover that there had been any other cases of sickness in adults or children either in the patient's compounds or in their vicinity. (But see below.) In the compound of

Case I there were four children.
Case II there were five children.
Case III there were ten other children.

The following is a list (with dates of onset in chronological order) of *all* cases that have been reported up to the present in Abeokuta :—

1. European case (Report 1), 10th May.
2. Native case (Report 1, Appendix 2), 22nd May.
3. Native case (Report 1, Appendix 1), 19th June.
4. Case II (this report), 1st July.
5. Syrian (this report), 31st July.
6. Case III (this report), 6th August.
7. Case I (this report), 10th August.



EXPLANATION :

1.—European case (Report I).
2.—Native case (Report I, Appendix 2).
3.—Native case (Report I, Appendix 1).
4.—Case II (this Report).
5.—Syrian (this Report).
6.—Case III (this Report).
7.—Case I (this Report).

It is of interest to note that Nos. 1, 2, and 4 (in above list) occurred within a circle of 350 yards radius, and within a period of about 52 days, whilst Nos. 3 and 5 occurred at a distance of about 300 yards from one another, and within a period of approximately 41 days. (See plan of Abeokuta.)

Whilst it is impossible definitely to connect causally any of these cases with one another, it appears to be clear that they must all (including the Syrian) have obtained their infection from a native source.

I have here, of course, assumed that the native Cases I, II, and III, were actually yellow fever, and though the clinical evidence available in the Father Superior's notes is incomplete, the fact that numerous similar cases have recently occurred in the Colony appears to lend a strong element of probability to the assumption.

E. J. W.

15th September, 1913.

Report No. 4

General Introduction

This Report deals essentially with the manifestations of yellow fever on ships and at Warri, Forcados, and Burutu, in the then Central Province of Southern Nigeria.

It has been convenient to divide it into three sections :—

I. Concerning the outbreak at Warri.

II. Concerning certain cases of fever at Forcados and Burutu.

III. Concerning cases of fever upon ships.

Seven appendices are added. Four of these are referred to in the body of the Report. The fifth consists of a Report on pathological lesions, by Dr. Turnbull, the sixth of some photographs illustrating various points mentioned in this and in my Report No. 1, and the seventh of plans and maps. I much regret that a limited experience of photography has militated against the production of better or more numerous photographs.

I am indebted to the Acting Principal Medical Officer for permission to include photographs Nos. 1, 6, 7 and 10, which belong to the local medical records at Lagos.

I have included in Section II a synopsis and tabular statement of the cases therein, as they constitute a well-defined group. This synopsis and tabular statement (and also the records of some other cases in the Report) are unfortunately incomplete, since certain information asked for by me has not been forthcoming.

The information asked for was as follows:—

(i) Records of blood examination with respect to the presence or absence of malaria parasites;

(ii) Records of blood examinations in respect to the presence or absence of *Paraplasma flavigenum*;

(iii) Results of blood examinations—leucocyte counts, etc.;

(iv) Laboratory reports upon organs submitted for examination.

Those cases which have been submitted to Investigators have the Commission Number noted by a †. In some instances, the number was, however, not ascertainable from the Medical Research Institute, and in such a note to this effect is made at the head of the case. In a proportion of these cases headed 'Commission number not available' it is not certain that they were ever submitted to an Investigator; these are marked with an asterisk (*). Where there is no note at the head of a case, this signifies that it was not sent to an Investigator.

I trust that a certain amount of repetition and, in places, a considerable degree of detail may be ascribed to a desire for accuracy, and to a wish to err rather on the side of elaboration than on that of omission.

E. J. W.

26th February, 1914.

SECTION I

Introduction.—This Section deals with the outbreak of yellow fever at Warri, in May and June, 1913, when two Europeans, engaged at a Factory (Store), contracted the disease—the former with a fatal termination.

Both lived in the same house in the firm's compound, which is

situated on the river bank (see Plans I and II, and map of Warri). The patient first attacked, whose case ended fatally—L. 26—lived in the assistants' part of the house (Bedroom IV, Plan II). Case L. 34 lived in the opposite wing (Agent's Quarters, Plan II).

On inspecting the premises, which are not 'mosquito-proofed,' I found the room which had been occupied by Case L. 26 to be unfavourably situated, both for light and ventilation, and inaccessible to breeze. The windows looked out upon a wall of corrugated iron, fifteen feet distant. It may well be that his resistance to disease was lowered by these conditions. I was informed that a new house was shortly to be erected.

During the daytime, the patient (L. 26) was engaged at his firm's store at Ogbe Ijoh, approximately one mile from the main establishment, but, in the evening, he was accustomed to do office work in the main store—D, Plan I—which is situated a few yards from the residential building.

After his removal to hospital, Case L. 34—the second patient—performed the evening clerical work. This store, which, I was informed, was infested with mosquitoes at that time, had, with the exception of the residential quarters, been the only place largely used by both patients, and the fact that the second patient first complained of illness twenty days after mosquitoes had had an opportunity of becoming infected from the first case, makes it appear probable that he received his infection there. It is, of course, also possible that he was infected from the same source, but in his rooms.

I ascertained that the first patient had almost certainly worked in the store on the evening before his admission to hospital, at which time he was probably in an infective condition.

The following are copies of the reports and charts of these two cases by the Medical Officer, Warri. It may be remarked that Case L. 26 received no quinine treatment, and that Case L. 34 received 5 grains quinine hydrochloride, on the day following admission:—

L. 26†

REPORT BY THE MEDICAL OFFICER, WARRI

On the 22nd May, 1913, I was called to a Factory to see the patient, who had reported himself sick to the Agent that morning.

On inquiry, I found that he was thirty years old, and had come out for the Firm eighteen months previously. He stated that it was his first experience of the tropics, and that he had not had any previous attack of fever. He took quinine regularly.

On examination, the patient was found to be a man of very powerful physique and truculent disposition. The temperature was 103·6°, the head and neck congested, and the eyes suffused. The pulse was 104, the skin was moist, heart and lungs were normal, and neither the liver nor spleen enlarged. There was no inclination to vomit, but the patient was restless and the fever was of a distinctly sthenic type. The bowels had not acted since the previous day.

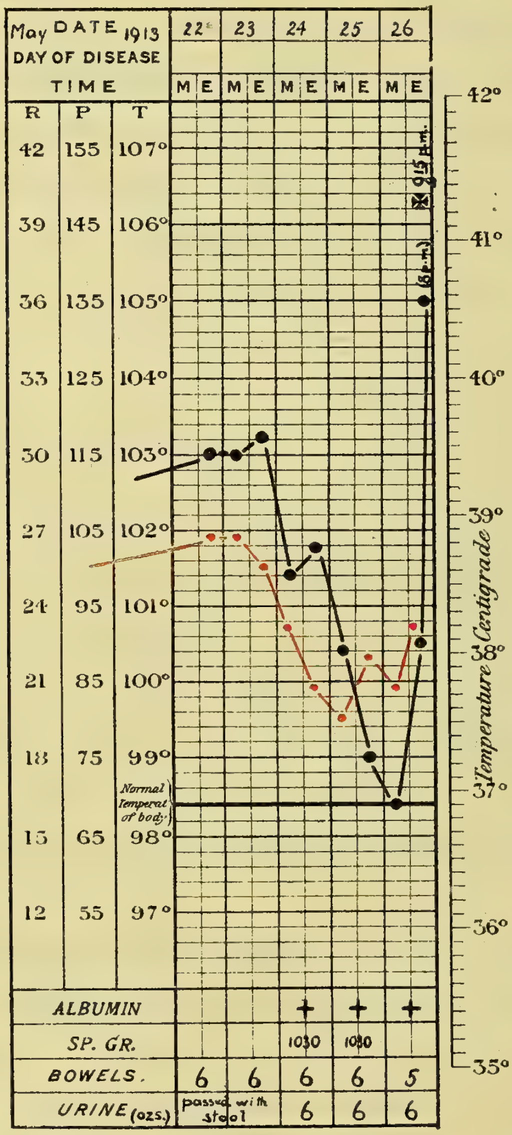


Chart 3.

I at once ordered him into hospital; gave hyd. subchlor. grains 5, and tried to obtain a specimen of his urine. This I found to be difficult on account of the obstinacy of the patient, who refused to pass it except with his motions. There were no parasites to be found in the blood, and, though the temperature and pulse both appeared to be more satisfactory, the general condition of the patient seemed to be serious, and, on the morning of the third day, a catheter was passed, and five ounces of urine, heavily loaded with albumen, withdrawn. On the same day, a remission occurred, and the patient became calmer, but the conjunctivae were jaundiced, and he vomited about six ounces of altered blood. On the morning of

the 26th, the temperature began to rise again, and the vomiting became incessant, and of the coffee-ground type. Salines were given freely throughout the illness, and, during the first three days, liquid nourishment was easily taken.

Death occurred at 8-45 p.m. on the 26th.

Post-mortem.—The heart and lungs were normal; the liver was yellow in colour and cut firmly; the size and weight were normal. There was intense congestion of the kidneys and spleen, but the latter was small and weighed under 4 ounces. The walls of the stomach were injected, and almost the whole of the mucous membrane was haemorrhagic, while the contents consisted of a tarry fluid, similar to that vomited during life.

From the clinical and post-mortem aspects, I must express my opinion that the patient died from yellow fever.

For pathological report see Appendix V, page 196.

L. 34†

REPORT BY THE MEDICAL OFFICER, WARRI

Age: 32 years.

Occupation: Agent at a Trading Company, Warri.

Previous History.—He has had ten years' Coast experience. Present tour commenced on the 31st January, 1913, and from that time to the date of present illness he resided at the Factory. He paid week-end visits to Sapele and Gana-

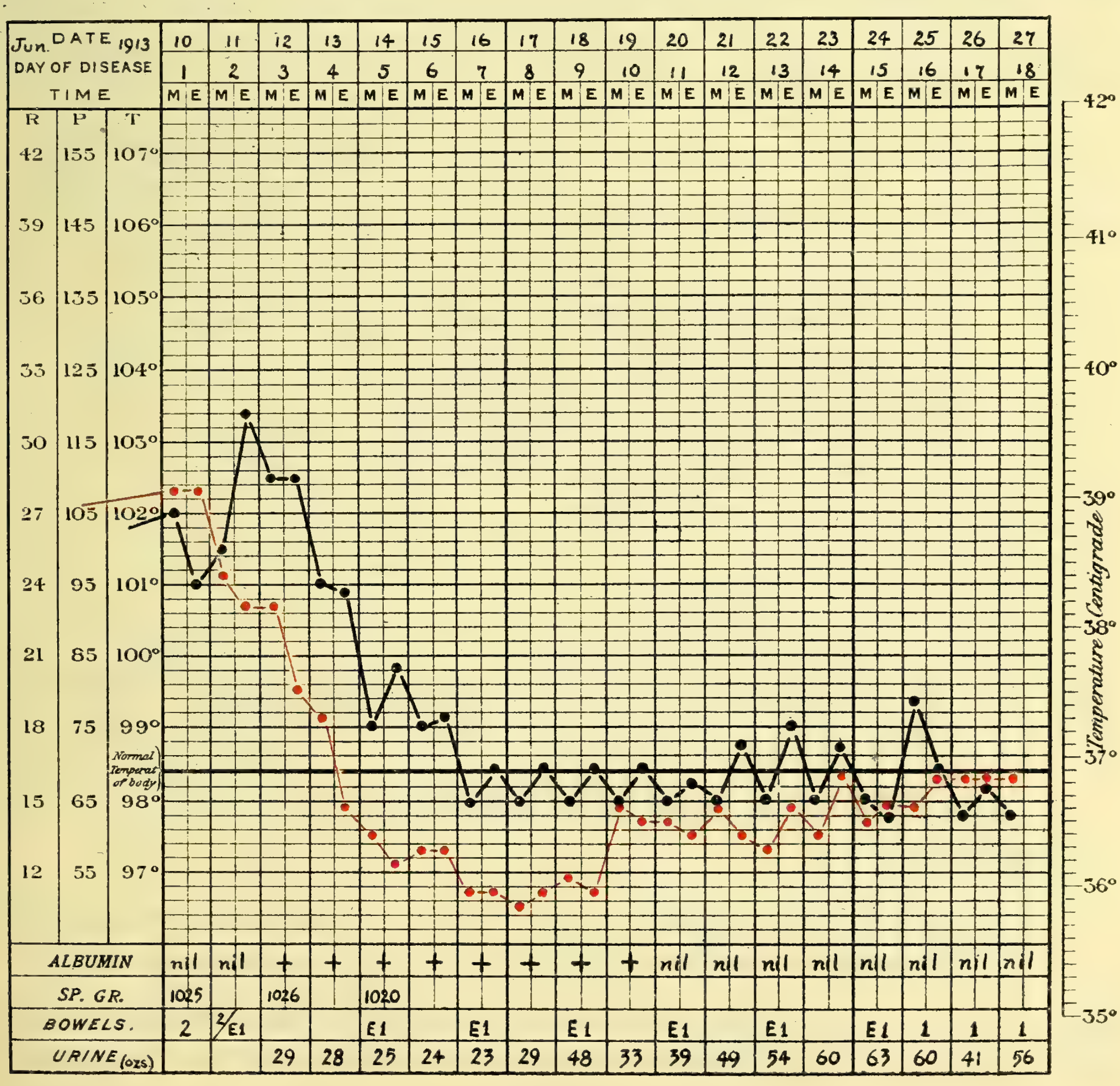


Chart 4.

Gana, but did not leave Warri during the last month. He had not been on the sick list this tour. His quinine habit is reported to have been irregular, and he was careless about his mosquito net.

History of Present Illness.—On the morning of the 10th June, he dressed and proceeded to the beach, apparently in his usual health, but about 10 a.m. he felt ill, vomited, and returned to bed. His temperature was 102°, and he was at once sent to hospital.

On admission, his temperature was 102·2°, the face flushed and eyes suffused. There was no abdominal tenderness or pain, but the patient complained of severe frontal headache. The tongue was thickly coated in the centre, but red at the tip and edges. The skin was dry ; pulse 108. He was screened off from other patients to be kept under observation, and hyd. subchlor. grains 5 given.

On the second day, the pulse was 80, though the temperature was 103°, and this, with the occurrence of albumen on the morning of the third day, was looked upon as settling the diagnosis. Haemorrhages from the gums, nose, fauces, and stomach (coffee-ground) occurred on the fourth day, and jaundice was well marked. He was given Sternberg's mixture at first, and, afterwards, the treatment was symptomatic. With the exception of a little Brand's Essence, he had practically no food for five days.

Vichy water was given and well retained. The temperature fell by lysis to normal on the sixth day, and remained so.

He was discharged to proceed home convalescent on the 16th day. The accompanying chart appears to be characteristic of one type of the disease. It will be noticed that the pulse fell to 50.

I.—*General Description of Warri District and Town.*

(*a*) *Warri District:* This is situated in the Niger Delta.

Boundaries:—

On the north by Sapele and Kevale Districts.
On the east by Aboh District.
On the south by Forcados District.
On the west by Forcados District.

Area:—1,276 square miles.

Total population:—

141,740, comprised of:
Natives: 141,614.
Europeans: 124 (including 49 who were on ocean boats).
Other non-West Africans: 2.
} Census, 1911.

(*b*) *Warri Town*

This is the headquarters of the Central Province, and is situated on one bank of the river of the same name—a water-way of the Niger Delta. The river is sufficiently deep for the navigation of ocean steamers, which are able to moor alongside the wharves.

The town stands upon flat ground and covers an area of approximately 300 acres. Some of the outlying traders' stores are erected on reclaimed swamp.

Total population: 2,567 (Census 1911).

The European population in May, 1913, was: Officials 22, Non-Officials 48, Syrians 1.

There are two native villages of moderate size within approximately half a mile of Warri.

II. *Rainfall and Temperature*

In Appendix III will be found a record of the monthly rainfall, together with temperature observations during 1911, 1912, and the first nine months of 1913. It will be seen, however, that these records do not in any way elucidate the aetiology of the cases at Warri. I quote them in order to maintain a certain uniformity with my reports upon other places, and also as negative evidence.

III.—*Previous Health and Habits of the Patients*

I was informed that:

(*a*) Case L. 26.

1. Had been in West Africa eighteen months (first tour) and had never complained of any illness during this period.
2. Had always slept in his own quarters.
3. Had always used a mosquito net, but on the night of the 16th May—five days before he became ill—he slept on the verandah without a net, and was so much bitten by mosquitoes that in the morning his face and arms were swollen. (This information was supplied by one of his fellow employees.) The Medical Officer also informed me that when first seen he was under a mosquito-net, which fell to the floor and was not tucked in under the mattress.
4. He was in the habit of wearing mosquito boots in the evening. During the day-time he wore boots or shoes.

(*b*) Case L. 34.

1. Had been some years in West Africa (present tour five and a half months).
2. Had always slept in his own quarters.

3. Had always slept under a mosquito-net.
4. Did not wear mosquito boots in the evening. During the day-time he wore boots.

I inquired particularly as to whether either of the patients was inclined to omit the use of the mosquito-net entirely, and was assured by the acting agent of the firm, who was well acquainted with both men, that this was not the case, but that Case L. 34 would occasionally arise at daybreak and lie outside the net, upon a sofa. The occurrence already mentioned of Case L. 26 having slept on the verandah without a net was, therefore, probably exceptional.

It should here be remarked that there had been no sickness among the other four Europeans in the factory or among the native employees (about 40) with the exception of one European, who had fever of one and a half days' duration, about the beginning of May.

IV.—*Actual Movements of the Patients for Three Months prior to their Illness*

Case L. 26 had not been away from Warri during this period.

Case L. 34 had been accustomed to pay week-end visits to Sapele and Gana-Gana, but had not left Warri during the last month.

With these exceptions, neither patient was known to have slept away from his quarters.

V.—*Prevalence at Warri of any suspicious Cases of Fever*

The following is an extract from a report by the Senior Sanitary Officer, who visited Warri in June in connection with the outbreak:

'In the endeavour to ascertain if there were any cases, or even suspicious cases, in the district, the Medical Officer let it be known among the Chiefs and people that all patients coming to hospital would be treated free, and that no fees whatever would be charged, but this led to no further information being gained.

'Inquiries were also made as to any cases of fever occurring in the district, but these only yielded negative results.

'The Sanitary Inspectors, during their house-to-house inspections, sought and inquired for any cases of illness, but

nothing could be found. Inquiries were also prosecuted among the neighbouring villages, but in his house to-house visits, and in his conversations with the Chiefs, by all of whom he was well received, the Medical Officer was unable to obtain any information in regard to cases of illness, and only saw one sick person, who was suffering from a purely local affection.

'The Commissioner of Police stated that he had received information of a form of sickness which had occurred in 1912, characterized by fever and a dark-brown vomit, but the Chiefs said they had not heard of it, and on inquiry, he had been unable to get any information relating to the affection, and concluded that the report which had been received was incorrect.

'The agents of the European trading firms having made definite arrangements for medical attendance, their European employees receive treatment immediately on complaining of sickness, and the native employees, when they are unfit for work, if they live on the premises, as very many do, are all sent to the hospital at once, so that the records there would immediately show any special sickness occurring at any of the factories. In addition, sanitary inspections are made by the Sanitary Inspectors two or three times weekly, who report daily to the Health Officer, so that he would receive early information of anything exceptional occurring.

'It cannot, of course, be said that the sanitary conditions under which these employees live are in all instances satisfactory, and, I regret to say, conditions such as these are not limited to the employees of the mercantile firms, but also exist elsewhere. . . . . .

'On 18th June, in company with the Provincial Medical Officer and the Medical Officer, Warri, I had a private interview with some of the most influential Chiefs, but could not obtain very much decided information except that there was no special sickness in the district, and that they had no information of any having been present; they, however, specially drew our attention to a disease they called "sebe," which, they said, was characterized by fever, yellow eyes, thick urine, and sleepiness, but there was no vomiting, and no loss

of appetite. The usual duration of the affection was, unless it terminated fatally, which was the case in about 10 per cent. of the cases, stated to be about three weeks. The Chiefs promised to have inquiries made, and to issue instructions that all cases of fever should be taken to the hospital.*

'On 19th June, at an official meeting of the Chiefs, specially summoned by the Honourable Provincial Commissioner, no further information was obtained. I heard from one or two sources that there was an idea prevalent, and one with which the Chiefs were imbued, that if any cases of yellow fever were found in any of their villages, they would run considerable risk of having them burnt down.

'On 24th June, a patient, a man from Sierra Leone, was admitted into hospital, suffering from a condition which was at once diagnosed by the natives as "sebe." He was jaundiced, the urine was bilious, there was no temperature, vomiting, nor pains, and the motions were "clayey." The case was diagnosed as one of catarrhal jaundice, and further observation only led to this being confirmed.

'It is, however, very probable that the term "sebe" refers to more than one affection.'

I took occasion again to interview some of the most influential Chiefs, in the hope of being able to obtain further information, but I have nothing to add to the Senior Sanitary Officer's remarks. I particularly asked the Chiefs to send me any cases of "sebe" that might occur, but without result. Is this disease, perhaps, the same as that mentioned as occurring at Ilaro (see paragraph X, Report No. 1)?

The Medical Officer, Warri, informed me that no suspicious cases of fever had come under his notice. However, bearing in mind a possible confusion between mild and atypical cases of yellow fever and cases of malaria mentioned again in Section VII (below)—(see also Report I, paragraph VIII)—I examined the clinical and *post-mortem* records from January, 1911, up to the time of my investigation (October-November). Out of 105 cases diagnosed as malaria during this period (natives), the presence of

* No cases were forthcoming.—E. J. W.

albuminuria is noted in two, which occurred in 1912, whilst its absence is noted in thirty-five. In the remaining sixty-eight cases there is no record of the urine.

Out of thirty-nine cases which occurred in 1913, albuminuria was noted to be absent in thirty-five; in the remaining four there is no record of the urine. Since examining these records I have been informed that the urine was probably tested in a larger proportion of the cases than my figures show, but that the result was not, in all instances, entered on the chart. (This remark also applies to the European statistics, section VII below.)

Under these circumstances, the figures quoted give no accurate indication of the proportion of cases in which albuminuria was or was not present. Having collected them, however, I quote them for what they are worth, and especially because nearly all the cases in 1913 are recorded.

(The number of cases of malaria given in this and other sections is not to be taken as necessarily representing the exact total treated in hospital during the period under consideration. In some instances the charts or notes have been missing or defective, and the numbers indicate, therefore, only those cases the records of which were available for scrutiny.)

The following are the two (1912) cases (A and B) in which albuminuria occurred. Both cases exhibit a suggestive pulse-rate. It will be remarked that they were both admitted to hospital about the same date. The patients did not live near one another, nor were they, as far as I could ascertain, in any way associated.

Case A

Sex: Male.
Age: 25.
Race: Native of West Africa.
Occupation: Interpreter.
Date of admission to hospital: 6th March, 1912.
Date of discharge: 16th March, 1912.
Diagnosis: Malarial fever.
No history of the case available.
Patient was treated with quinine throughout.

He was still acting as Interpreter on the occasion of my visit to Warri. I interviewed him and found him to be a man of some intelligence. He was quite positive that there were no cases of sickness in or around his house at Okeli (a native

village in the neighbourhood) at the time of his illness, nor that there was any exceptional mortality among either adults or children.

He informed me that he had not been away from the immediate neighbourhood for some months previous to his admission to hospital.

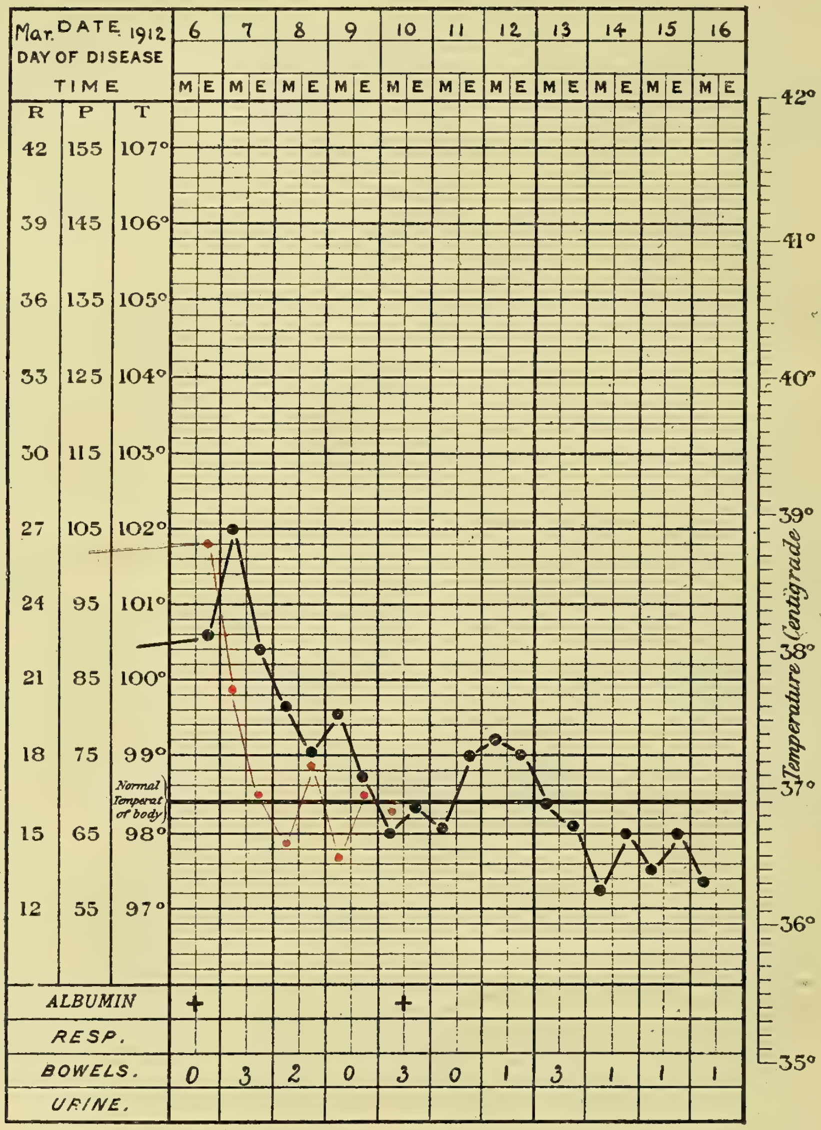


Chart 5.

Case B

Sex : Male.
Age : 40.
Race : Native of West Africa.
Occupation : Cooper at a Factory.
Date of admission to hospital : 7th March, 1912.
Date of discharge : 14th March, 1912.
Diagnosis : Malarial fever.

No history of the case available. I found on inquiry that the patient had left the firm's employ some months ago, and returned to Accra. At the time of his illness, he had been in the firm's employ for many months.

He was treated with 5 grs. quinine daily.

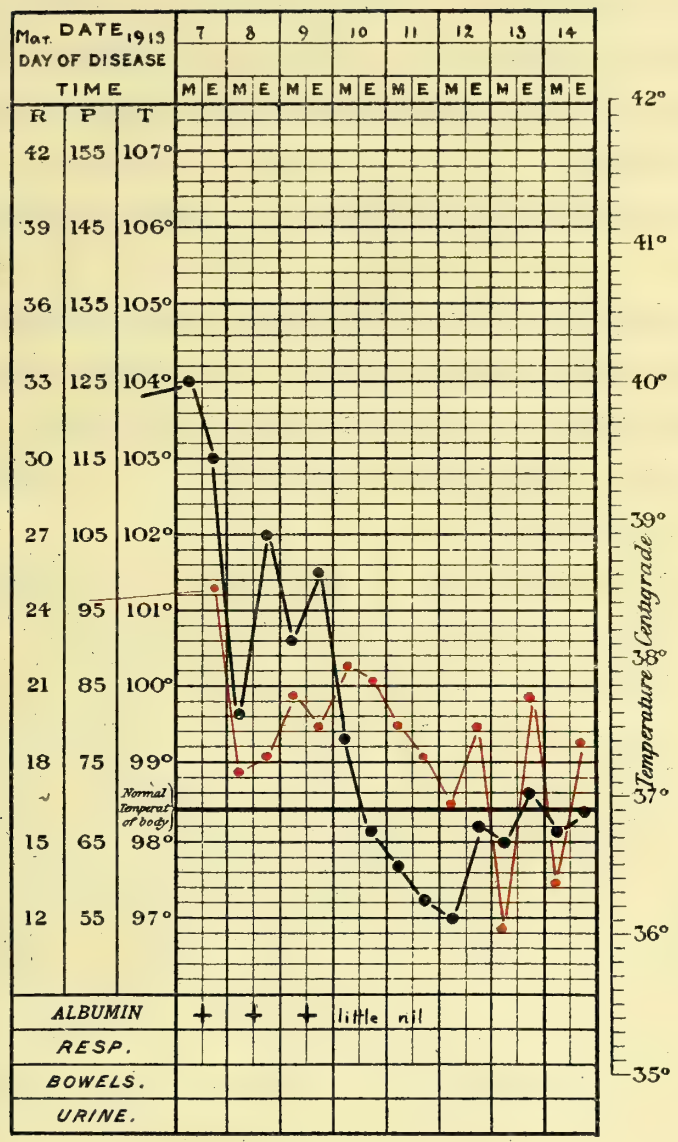


Chart 6.

VI. *Any recent (suspicious) high mortality among Natives at Warri, especially Native Children*

There are no statistics available which would elucidate this.

Registration of deaths is not enforced, and the number registered is negligible, averaging approximately two or three per month. The data available in the Burial Register are also unreliable, the number of cemetery burials being relatively few, whilst the diagnosis of the cause of death has in many cases to be made from description only.

The Medical Officer, Warri, informed me that no exceptional mortality had come under his notice, and the representative Chiefs whom I interviewed on the matter also denied its occurrence in the localities under their jurisdiction.

VII.—*Number of Europeans in Warri and suspicious cases of Fever amongst them during the last Twelve months*

The number of Europeans resident in Warri during May and June was as follows:

May: 22 officials, 48 non-officials. June: 22 officials, 56 non-officials.

There was also one Syrian resident during these months.

There were no cases recorded as 'suspicious' during the preceding twelve months, and no suspicious cases occurred among the remaining four European employees of the firm, either before or after Cases L. 34 and L. 26.

Out of the seventy-two Europeans (including one Syrian) resident in Warri at the time of my investigation (October, 1913), I found that eight had lived in regions where yellow fever is endemic before coming to West Africa, whilst one informed me that he had suffered from the disease fourteen years ago on an ocean-going vessel at Santos. He is an engineer, and was then about twenty-two years of age. He told me that there were no others sick on the ship at the time; that he first felt ill after the vessel had left Rio for Santos (one day's journey), and that the condition was diagnosed at the latter port as yellow fever. He remembers that the illness began with frontal headache of extraordinary violence, and that there was no vomiting. He was prostrated for three days, and was about again in a week.

In view of a perhaps previously acquired immunity, I have collected the figures appended, for the sake of clearness, in tabular form (Table 1). It will be seen, however, that in three cases the interval of residence in a non-endemic area, after leaving the endemic area, was perhaps long enough to have destroyed immunity acquired by residence, in contradistinction to immunity acquired by having passed through an attack of the disease.

None of these persons (with the exception noted) have ever had yellow fever, so far as they are aware. From the same point of view, a table (Table 2) is appended of the remaining sixty-four residents. It will be seen that, as in the similar tables in Section II of this report, and in Report No. I, some of the persons were not actually resident at the time the disease first declared itself, but they are included for the sake of completeness.

While touching on the question of immunity, it will be remarked that the deceased (Case L. 26) was in his first tour, and had been in West Africa eighteen months, i.e., long enough to have his resistance to disease thoroughly lowered in whatever part of 'the Coast' he might have been resident, but especially so in the exceedingly enervating climate of Warri (not to mention his unfavourable domiciliary conditions) without the compensatory advantage of an immunity to yellow fever, which by some is supposed to accrue from prolonged residence in an endemic zone. The patient (L. 34), on the other hand, who recovered, had been some years in West Africa, and was in the sixth month of his tour

TABLE NO. 1

Number	Number of years resident in an endemic area other than West Africa	Period between residence in an endemic area and first coming to West Africa. (Interval of residence in a non-endemic area.)	Number of months in West Africa since last in Europe	Number of months in Warri since last in Europe	Number of months in other parts of West Africa since last in Europe	Number of months in West Africa (not including leave) since first coming to West Africa
1. Government official	32 years	4 months	9 months	7 months	2 months	33 months
2. " "	15 "	No interval	11 "	11 "	—	23 "
3. " "	10 months	18 months	6 "	6 "	—	30 "
4. Non-official ...	Trading for 3 years to West Indies	5 years	1 month	1 month	—	—
5. " ...	Trading for some years to West Indies	5 "	20 months	20 months	—	About 100 months
6. " ...	Engineer on board ship trading to West Indies for some years	5 "	1 month	1 month	—	—
7. " ...	7¾ years	6 weeks	6½ months	6½ months	—	117 months
8. " ...	9 months	—	276 months (23 years)	48 "	228 months (19 years)	276 months (23 years)

NOTE.—No. 8 is a Syrian.
No. 6 suffered from yellow fever at Santos about fourteen years ago.

Table No. 2

Number	Number of months in West Africa since last in Europe	Number of months in Warri since last in Europe	Number of months in other parts of West Africa since last in Europe	Total number of months resident in West Africa since first coming to West Africa (not including leave)
1. Government official... ...	10	10	—	About 120
2. ,, ,, ...	3 weeks	3 weeks	—	,, 27
3. ,, ,, ...	9	7	2	70
4. Wife of 3	6	6	—	34
5. Government official... ...	12	6	6	60
6. ,, ,, ...	8	8	—	47
7. ,, ,, ...	2	1	1	28
8. ,, ,, ...	1	1	—	13
9. ,, ,, ...	2	2	—	65
10. ,, ,, ...	7 weeks	5 weeks	2 weeks	72
11. ,, ,, ...	8	4	4	18
12. ,, ,, ...	4½	1	3½	27½
13. ,, ,, ...	5	1	4	80
14. Wife of 13	5	1	4	26
15. Government official... ...	12	11	1	About 144
16. ,, ,, ...	4	4	—	126
17. ,, ,, ...	5	5	—	97
18. ,, ,, ...	11	10¾	1 week	72
19. Non-official	7	4½	2½	About 130
20. ,, ...	11	11	—	11
21. ,, ...	10	3½	6½	102
22. ,, ...	20	20	—	44
23. ,, ...	21	19	2	44
24. ,, ...	8	2	6	8
25. ,, ...	5	5	—	5
26. ,, ...	4½	3½	1	4½
27. ,, ...	4	3½	½	51
28. ,, ...	12	3	9	26
29. ,, ...	4	4	—	99
30. ,, ...	24	12	12	24
31. ,, ...	26	2½	23½	26
32. ,, ...	25	25	—	51
33. ,, ...	29	8 days	28¾	61
34. ,, ...	18	18	—	55
35. ,, ...	3	3	—	3
36. ,, ...	6	6	—	6
37. ,, ...	32	32	—	32
38. ,, ...	18	18	—	18
39. ,, ...	6	6	—	6
40. ,, ...	5	5	—	5
41. ,, ...	1	1	—	1
42. ,, ...	3½	3½	—	85
43. ,, ...	25	25	—	103
44. ,, ...	3½	3½	—	3½
45. ,, ...	60	59	1	192
46. ,, ...	4	4	—	360
47. ,, ...	10	10	—	72
48. ,, ...	27	25	2	27
49. ,, ...	—	14	—	—
50. ,, ...	24	15	9	24
51. ,, ...	22	22	—	58
52. ,, ...	8	8	—	76
53. ,, ...	3	3	—	39
54. ,, ...	16	16	—	16
55. ,, ...	11	11	—	11
56. ,, ...	4	4	—	4
57. ,, ...	14	14	—	64
58. ,, ...	4½	4½	—	4½
59. ,, ...	3 weeks	3 weeks	—	3 weeks
60. ,, ...	13½	13½	—	13½
61. ,, ...	6½	6½	—	30½
62. ,, ...	6	6	—	6
63. ,, ...	6	6	—	42
64. ,, ...	20	9	11	20

In view of the fact that atypical and mild cases of yellow fever may escape recognition and may possibly be mistaken for malaria (Guiteras), I examined the available records of cases of malaria among Europeans, from the commencement of 1911 up to the time of my investigation (October-November), particularly with reference to the occurrence of albuminuria.

Out of ninety-four cases, the presence of albuminuria is noted in eight. It is noted as absent in forty-three, whilst in the remaining forty-three cases there is no record of the urine. (Of the forty-three cases in which there is no note respecting the urine, thirty-eight occurred in 1911.)

In five out of the eight cases with albuminuria, the association of this condition with other features appears to be of considerable significance.

In the sixth case the patient, I was told, suffered from a profuse purulent urethritis. Leaving out of consideration in this case (No. 6) the albuminuria, certain other characters make it desirable to include it in this series.

No 'suspicion' attaches to the remaining two cases, which are accordingly omitted.

I would here remark that the question of the interference of a urethral discharge with the tests for renal albuminuria, which, as far as I am aware, has never been accurately investigated, is an important one, particularly in regard to natives, among whom, at any rate in the more 'civilized' parts of the country, gonorrhœa is generally admitted to be very prevalent. Allbutt's 'System of Medicine' states that: 'pus present alone in the urine, unless the amount of it be very large, does not cause more than a trace of albumen.' The investigations into this matter which I have so far been able to make appear to suggest that filtered urine which has contained pus does not necessarily yield a positive test for albumen, and that considerations such as degree of dilution of the pus, interval of time between the act of micturition and the application of the test, etc., have to be reckoned with (see Table 3). It would certainly appear desirable definitely to exclude the presence of urethritis in testing for albumen, but the fact that febrile conditions, at any rate temporarily, inhibit the activity of the gonococcus, here again introduces a possible source of fallacy, and

a reaction for albumen, at the time negative on account of pyrexia, might later, on reduction of temperature, become positive and be wrongly interpreted as a renal albuminuria.

It is obvious that in cases, particularly in natives, where a positive diagnosis of yellow fever may be largely dependent on the presence of albuminuria the question of the possible vitiation of the test is of great importance.

(Up to the time of my departure from the Colony I had tested the urine in seven cases of uncomplicated gonorrhoea. These are shown in tabular form (Table No. 3). I had intended, of course, to collect a much larger number.

Incidentally, the greater delicacy of the boiling test as compared with the nitric acid test, is illustrated. The former test is also to be preferred to the latter in these cases on account of the fact that a precipitate of resinous bodies is produced by nitric acid which might cause confusion in cases where oil of copaiba has been taken. This oil I have seen exhibited for sale to natives.)

TABLE No. 3

No.	Ozs. of Urine	Discharge	Immediate reaction on boiling	Immediate reaction c̄ HNO_3	Reaction on boiling after standing	Reaction c̄ HNO_3 after standing
1	2	Copious purulent	+	...	...	...
2	12	Fairly copious purulent	–	...	...	...
3	5	Fairly copious purulent	...	...	Very faint cloud after one hour	– after one hour
4	8	Copious purulent	–	–	Faint cloud after one hour	– after one hour
5	1	Copious purulent	+	–	+ after one hour	– after one hour
6	1	Fairly copious purulent	Very faint cloud	–	Very faint cloud after one hour	– after one hour
7*	5	Copious purulent	...	...	Very faint cloud in first part after 2½ hours. × in second part after 2½ hours	– in both parts after 2½ hours

NOTE.—In each case the urine was filtered before testing so as to obtain a clear filtrate.

* The urine in this case was passed into two separate vessels, the first part consisting of 1 ounce, the second of 4 ounces.

Case I

Race : European.

Age : 24.

Sex : Male.

Occupation : Trader.

Date of admission to hospital : 13th December, 1911.

Date of discharge : 22nd December, 1911.

Diagnosis : Malarial fever.

There are no notes available of the history or course of the case, except such as are entered on the temperature chart.

He was treated with 5 grs. quinine three times a day, saline aperients, and a mixture of carbonate of bismuth, hydrocyanic acid and chloroform water.

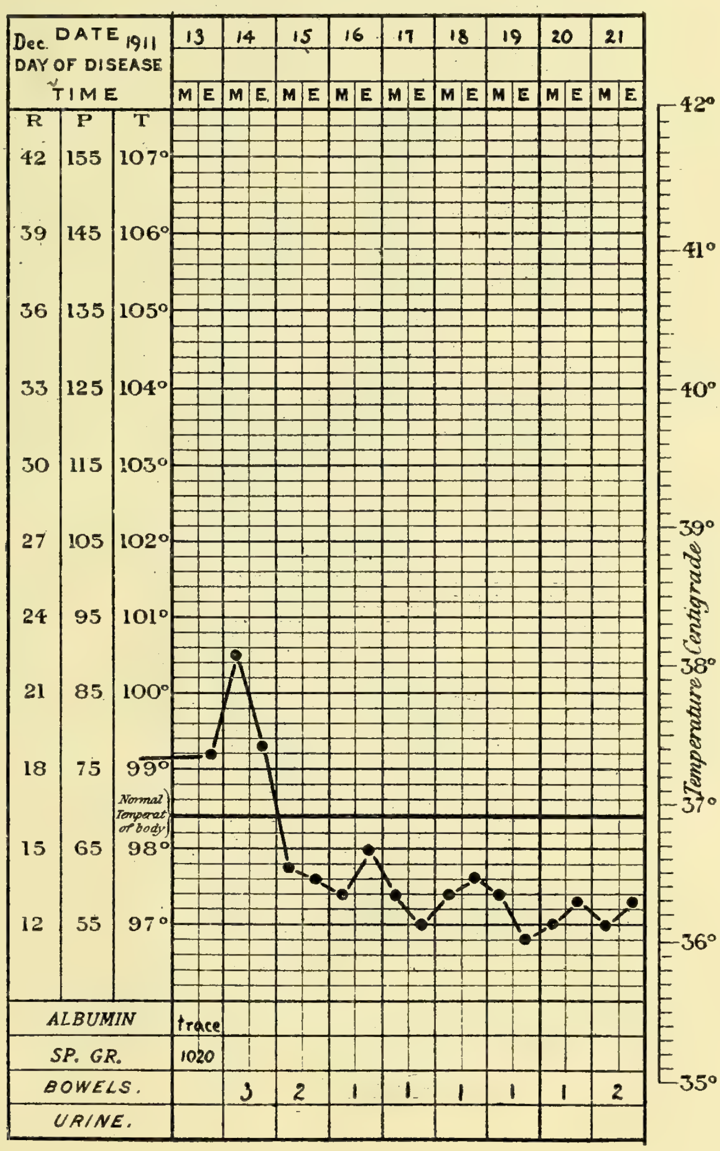


Chart 7.

Case 2

Race: European.

Age: —

Sex: Male.

Occupation: Government official.

Date of admission to hospital: 20th December, 1911.

Date of discharge: 23rd December, 1911.

There are no notes of the case except such as are entered on the temperature chart.

The treatment consisted of 5 grs. quinine daily and a 'tonic' mixture.

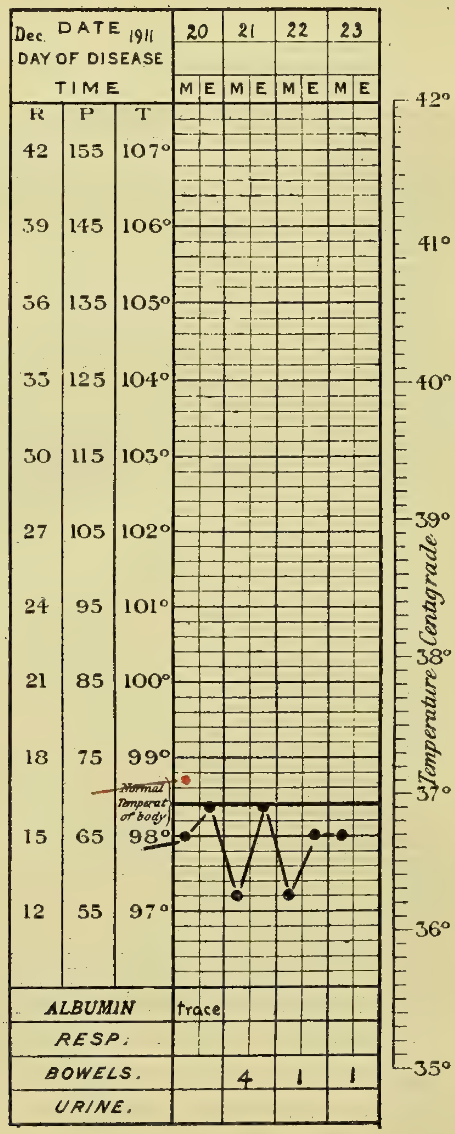


Chart 8.

Cases 3, 4 and 5 (Europeans) came from the s.s. 'Thomas Holt,' a cargo-boat, which was, at the time, lying at the wharf at Warri.

The ship had left Liverpool on the 5th July. The following had been her movements as closely as could be ascertained, kindly supplied to me by Messrs. John Holt's agent at Warri:—

Left Liverpool, 5th July.
Arrived Axim (Roads), 24th July.
Arrived Warri (wharf) *viâ* Duala, 11th August.
Left Warri for various ports on Niger River, 16th August.
Arrived Warri (wharf) from Niger River, 5th September.
Left Warri for Niger River, 12th September.
Arrived Onitsha (Niger River), 14th September.
Left Onitsha, 17th September.

I was informed that the vessel carried no deck passengers (natives) but, as usual, embarked a native crew on reaching the West Coast of Africa.

It is unlikely that these natives, coming off to the ship as they do in open surf boats, with a characteristically scanty spare wardrobe, would have been the means of conveying mosquitoes on board. On the other hand, it is possible that some of these insects, having gained access to the vessel on a previous voyage, may have survived a voyage as stowaways to Europe and back, and may have become infected from the native crew, or that mosquitoes which gained access to the vessel subsequently while in Southern Nigerian waters became infected from the same source.

Natives suffering from yellow fever are, it would seem, not necessarily even temporarily incapacitated from work.

No members of the native crew were reported 'sick,' either at the time of the patients' illness or within a period of some weeks before or afterwards.

From the movements of the vessel set out above, it is seen that she spent some weeks in the Niger River and creeks of the Delta, during which time she may have become infected, and that Forcados with its large river traffic (see Section II) may have been the source of infection. In the course of my inquiry I visited Onitsha, but there is no record in the hospital of any case of sickness having been treated on the 'Thomas Holt' while she was there.

Case 3. L. 66†

Race: European.

Age: 22.

Sex: Male.

Occupation: Engineer on s.s. 'Thomas Holt.'

Date of admission to hospital: 11th September, 1913.

Date of discharge: 30th September, 1913.

Diagnosis: Malarial fever with albuminuria.

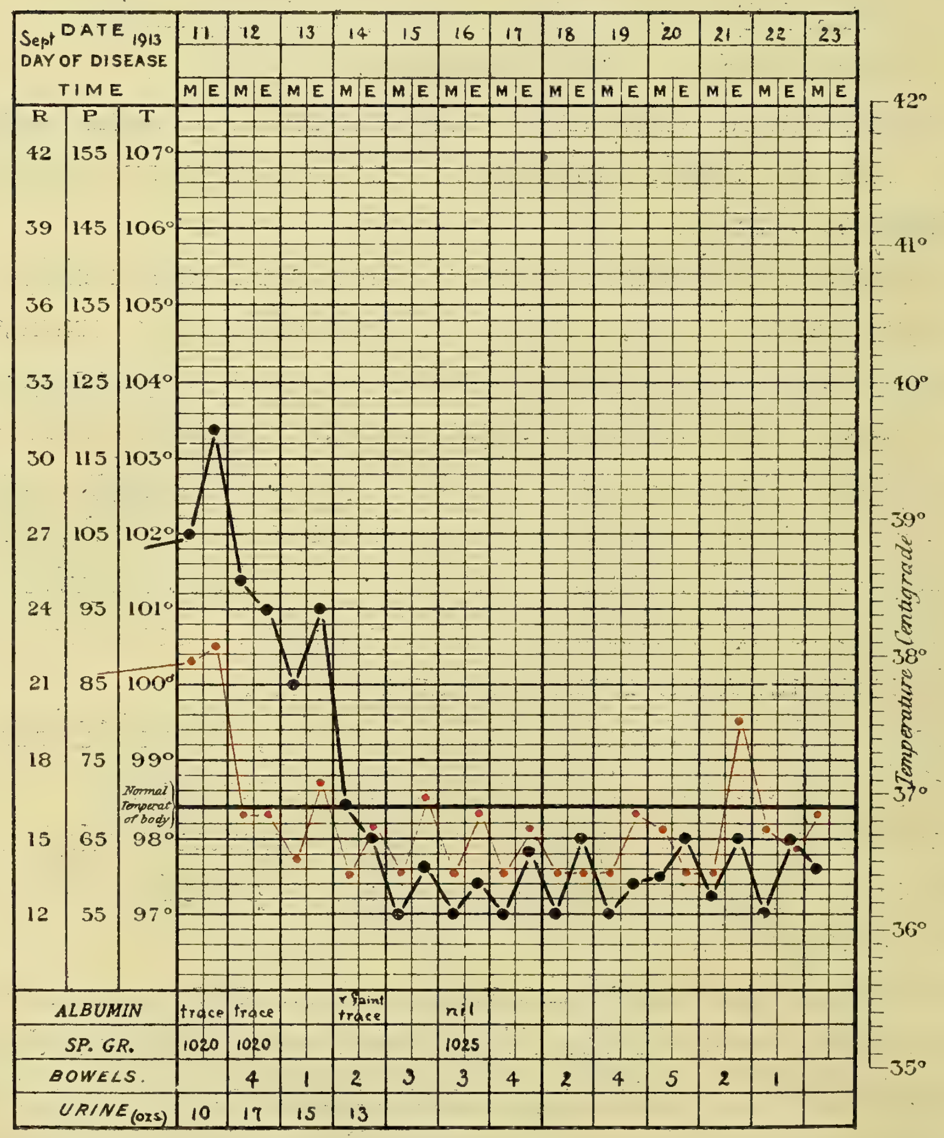


Chart 9.

CASE 4. L. 68†

Race: European.
Age: 22.
Sex: Male.
Occupation: Steward on s.s. 'Thomas Holt.'
Date of admission to hospital: 11th September, 1913.
Date of discharge: 30th September, 1913.
Diagnosis: Malarial fever with albuminuria.

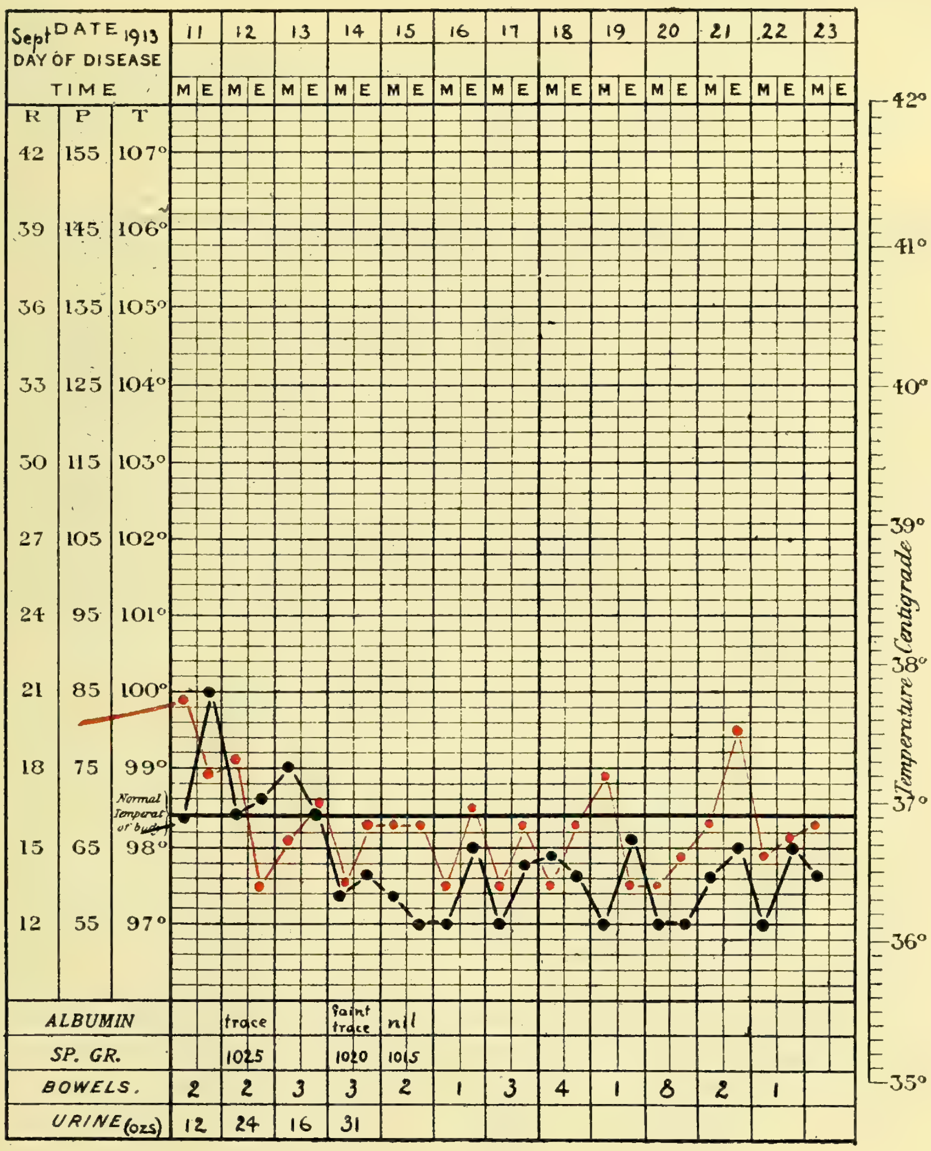


Chart 10

CASE 5. L. 67†

Race: European.
Age: 23.
Sex: Male.
Occupation: Engineer s.s. 'Thomas Holt.'
Date of admission to hospital: 11th September, 1913.
Date of discharge: 30th September, 1913.
Diagnosis: Malarial fever with albuminuria.

The following are the notes of cases 3, 4 and 5, by the Medical Officer, Warri:—

'I was called to see these patients on the afternoon of the 11th instant, and was told by the Chief Steward that they had been ill for two days with vomiting and fever ranging from 104° to 105°. I asked the Chief Steward to take a temperature with my thermometer and noticed that he read it accurately. The patients were at once removed to the European Hospital, and kept in mosquito-proof quarters.

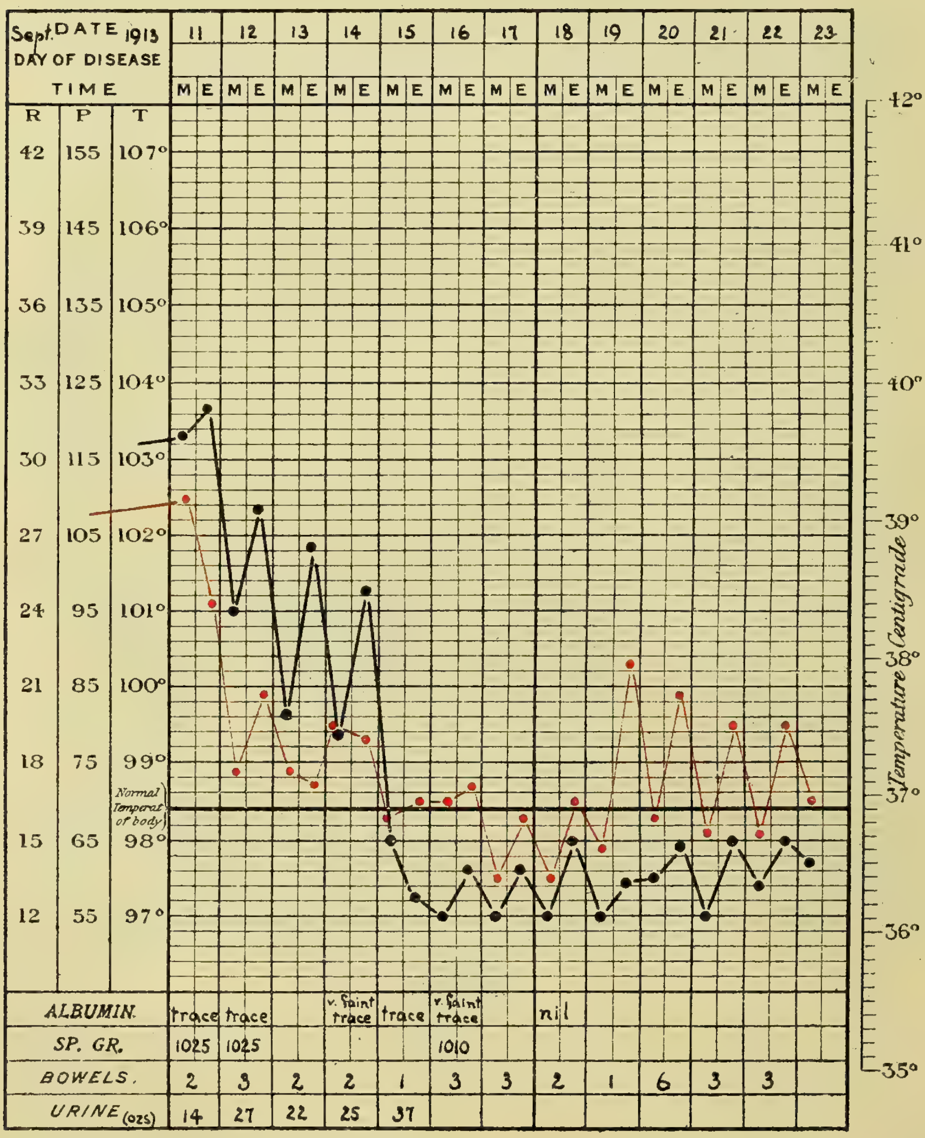


Chart II

'In 3 and 5 parasites were found, but the blood examination of 4 was negative. All had albuminuria, as will be noted from the accompanying charts, but no vomiting occurred after admission nor any other symptom suggestive of yellow fever.

'Blood films have been sent to Yaba, and I am forwarding a copy of this report to the same quarter. I could find no other cases of fever on the "Thomas Holt," and the agent, who is in communication with it, has heard of no further sickness on board.

'I am of opinion that these are not yellow fever cases, but await the result of the blood examination.'

Cases 3, 4 and 5 received 10 grs. quinine hydrochloride daily.

Case 6

Race: European.
Age: 17.
Sex: Male.
Occupation: Steward on s.s. 'Lulu Bohlen.'
Date of admission to hospital: 3rd September, 1913.
Date of discharge: 10th September, 1913.
Diagnosis: Malarial fever with albuminuria.

The attached temperature chart presents the available record of the case.

The Medical Officer, Warri, informed me, as already mentioned, that the patient had urethritis.

Quinine treatment: 10 grs. hydrochloride daily.

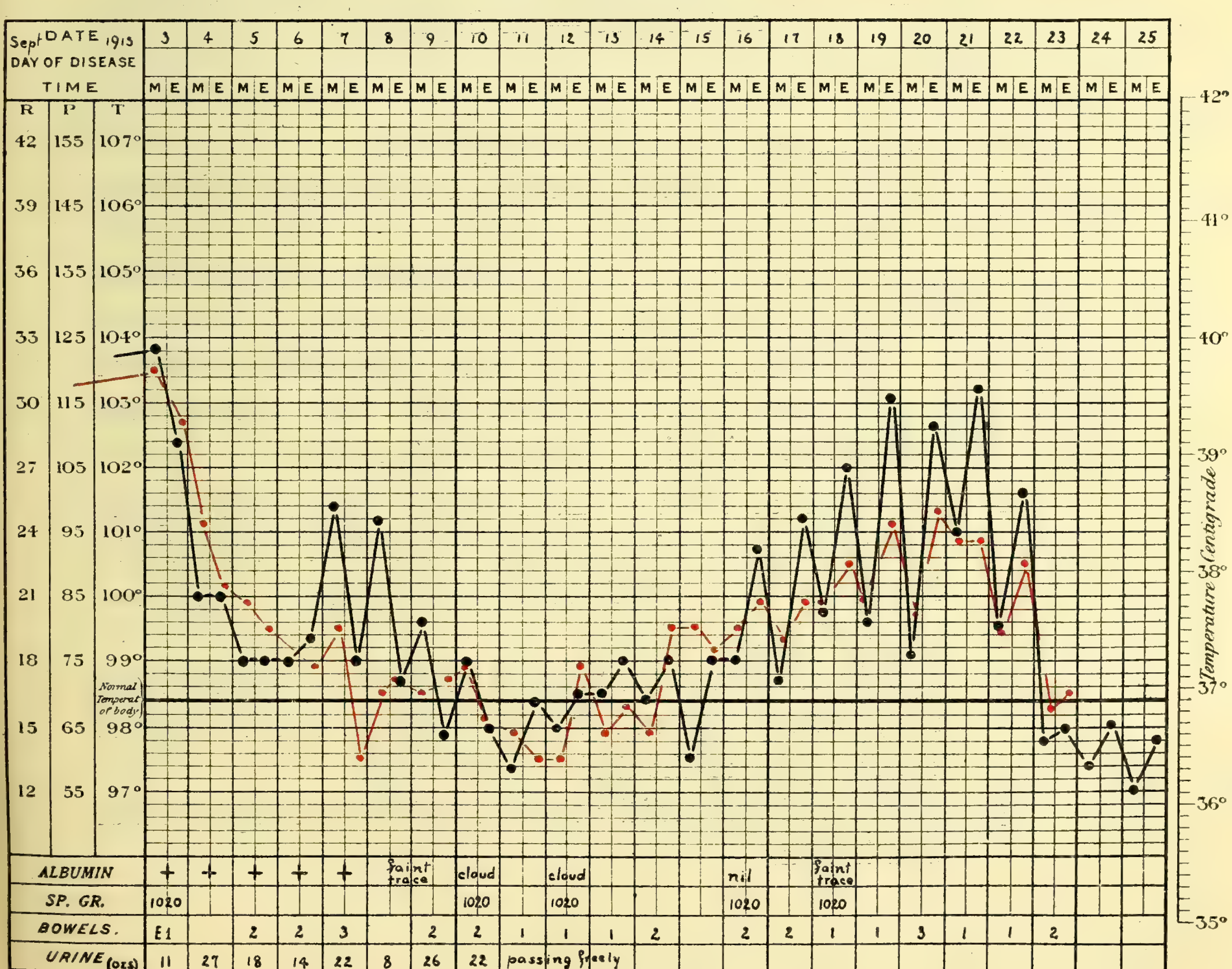


Chart 12

The 'Lulu Bohlen' is a cargo-boat plying between Hamburg and the West Coast of Africa.

On arrival at 'the Coast' she, as usual, embarked a native crew, the possibility of infection through which has already been discussed. She *may* have carried deck passengers, but I have been unable to ascertain this definitely.

The following were her movements prior to the occurrence of the case (it should be remarked that the time-table is not strictly observed by cargo-boats):—

Hamburg, 14th July.
Rotterdam, 18th July.
Las Palmas, 27th July.
Capa Palmas, 6th August.
Accra, Addah } 9-11th August.
Forcados, 13-17th August.
Burutu, Warri, Koko, Sapele } 21st August—7th September.

Left Warri, homeward bound, 7th September.

Whilst at Warri the vessel was moored alongside the wharves shown in the plan.

In reference to Case 6 it should be noted that the captain of the 'Lulu Bohlen' died at Koko on 31st August, under circumstances of doubtful significance. An inquest was held, the finding of which was 'death from fracture of the skull.' No autopsy had been made. The following is a *resumé* of the inquiry:—

1. The mate of the s.s. 'Lulu Bohlen' heard the captain fall down from his room on to the deck. Found him insensible with blood flowing from mouth and nose. He died in five minutes.
2. The doctor of the s.s. 'Prahsu,' from what he heard and saw, concluded death to have been due to a fracture of the fore part of the skull due to a fall.
3. The second mate said deceased had never complained of bad health.

4. The Agent of the African Association (a trading firm) stated that deceased informed him that he was better of late but had been coughing badly.
5. The engineer of the 'Lulu Bohlen' stated that deceased had been feeling sick at night and slightly deaf in the mornings for fourteen days.
6. The finding was that death was due to fracture of the skull, due to a fall.

Of the above six cases it will be seen that:—

(*a*) Nos. 1 and 2 were admitted in the same month and on the 13th and 30th respectively:—

(*b*) Nos. 3, 4, 5 and 6 were taken from ships, the first three from the same vessel and at the same time, whilst in the case of No. 6 a death had occurred on the ship three days before the patient was taken ill and eighteen days after the vessel had arrived at Forcados, where two cases of 'fever undiagnosed' had occurred in natives (in May and July)—see Section II. It is much to be regretted that the available details respecting this death are unsatisfactory. The epidemic character of Cases 3, 4 and 5, taken in conjunction with their clinical features, appears to be significant.

In Appendix I will be found the notes of two European cases—labelled A and B—which occurred at Warri in 1912 and 1913. I include them in this report because they are diagnosed as febricula, which disease forms one of the subjects of inquiry of the Yellow Fever Commission.

As in some text-books on Tropical Medicine emphasis is laid upon the differential diagnosis between yellow fever and haemoglobinuric fever, I have scrutinized the records of cases of the latter disease at Warri. There can, I think, be no doubt about the correctness of the diagnosis in these cases.

In 1911 there were no cases.

In 1912 there were three European cases and one in a West African native.

In 1913 there were no cases up to the end of September, but one occurred in a European in October at the time of my inquiry at Warri, which I had the advantage of observing in consultation with the Medical Officer. If I may venture an opinion on the basis of a very small experience of yellow fever (European and native)

and of blackwater fever (European and West Indian negro) I should say that the occasions on which the differential diagnosis between the two diseases comes into question must be rare.

VIII. *Conditions as regards* Stegomyia *Breeding at Warri, especially near residence of and places frequented by the patients*

I inspected a large proportion of the compounds of European officials, native officials, and the general native population, and found them very free from breeding places.

This was also the case in regard to the premises of the mercantile firms, all of which I inspected. Only once did I find larvae in Warri during my inquiry: in one of the trader's compounds on the river bank. They were in the zinc lining of a packing-case that was in use as a receptacle for rubbish.

I inspected sixty-three native dwellings; eleven canoes (not in use); thirty-three water-tanks (in five the gauze was defective); twelve rain gutters; and eleven receptacles for water, such as metal pots, barrels, &c., all taken at random. There were no larvae in any of them. The wells were covered in with one exception, and in this also I failed to find larvae.

There are two villages of moderate size within approximately half a-mile of Warri. I inspected thirty-six of the houses and found larvae in none, in spite of the fact that some water pots raised on wooden tripods in the streets in connexion with fetish worship were swarming with them. These villages are subject to frequent visits by the Sanitary Inspector.

The water supply in Warri for both Europeans (rain-water tanks) and natives (mainly well-water) is, I am informed, adequate, so that there is no necessity for undue economy and protracted storage.

The occurrence of cases of yellow fever would naturally have the effect of greatly stimulating anti-mosquito measures, so that the conditions as I found them some time afterwards probably afford no adequate indication of the state of affairs at the time. I therefore quote the following remarks from a report made in June by the Acting Sanitary Officer:—

'Distribution of *Stegomyia*. They are found more or less

all over the station, but were undoubtedly very much more numerous along the river front in the European traders' compounds than anywhere else. In some of these, *Stegomyia* larvae were found in large numbers in roof gutters, packing-cases, barrels, tins, &c., and * * * 's compound had by far the largest number of breeding places. There was a large collection of empty packing-cases piled up behind * * * 's shop, and the rains had caused the wood to swell so much that the lower tiers were capable of containing six or more inches of water. *Stegomyia* larvae were found in these in large numbers.

'Two or three days after the removal of this breeding place, the shop, which had been infested with mosquitoes, was comparatively free from them. In the Government Rest House, which is situate next to * * * 's compound and to leeward of it, there were also many mosquitoes, with a fair number of *Stegomyia* amongst them, which had doubtless come from Messrs. * * * 's compound.*

'The compounds of the European officials, native clerks, and general native population were remarkably free from breeding places. In the pond and numerous water-holes on the golf course there were enormous numbers of mosquito-larvae; considerable numbers were collected and hatched out but none proved to be *Stegomyia*. Those hatched out were species of *Culex* and *Pyretophorus*.'†

I was informed by the Agent of a trading company that the number of mosquitoes, especially during the first half of the year, appeared to be much in excess of previous experience.

On inspecting their premises I observed a number of canoes (eleven) moored at their wharf (see Plan I). These canoes were laden for the most part with native food-stuffs. I was informed that there is a constant succession of craft which make this wharf

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* This Rest House has since been rendered mosquito-proof.—E.J.W.

† In view of the fact that Dr. Laurie, the Junior Sanitary Officer, had found *Stegomyia* breeding in pools at Forcados—Section II—I carefully investigated the possibility of similar conditions existing at Warri. I failed, however, to find larvae in any pools, or in swamp near the town. The pools mentioned above by the Acting Sanitary Officer as existing on the golf course had dried up at the time of my visit.—E.J.W.

their stopping place. They come from widely separated parts of the Niger Delta, and frequently remain alongside overnight. I was unable to discover any larvae in the water which they nearly all contained to a greater or less extent, probably because canoes in use have frequently to be baled out. (In canoes which are not in use larvae may often be found.) The presence of infected natives in such canoes would, however, constitute a perpetual danger to the European inhabitants of the firm's compound.

The firm's agent informed me that canoes from Burutu (*vide* Section II) usually go to Ogbe Ijoh (New Warri) and do not stop at their wharf, but that natives disembark from the bi-weekly launch from Forcados and Burutu opposite their premises, which often remains moored to the wharf until the following day. The facilities, therefore, for the transport of infection direct from Burutu and Forcados, where cases in natives were occurring at the time of the Warri outbreak (Section II) were considerable. It will be seen also (Section II, paragraphs VI and VII) that launches and steamers which moor alongside the wharves may play no small part in the reinforcement of the supply of stegomyia mosquitoes in Warri.

The following are the mosquito indices (all varieties) for the years 1912 and 1913, based on the observations of Native Sanitary Inspectors:—

	1912.	1913.
Quarter ending 31st March... ...	0·2	0·23
,, ,, 30th June	0·48	0·51
,, ,, 30th September ...	0·45	0·36
,, ,, 31st December ...	0·23	

Anti-mosquito work.—Roof and gutters are cleaned, drains and pools oiled, houses and compounds inspected and general anti-mosquito work performed according to a definite routine by a staff of four Sanitary Inspectors, two headmen, and thirty-four labourers. This staff is under the direct control of the Medical Officer, and also attends to general sanitary work.

Convictions under the Mosquito Ordinance.—From January to June, 1913, thirty-one convictions were obtained, the total in fines imposed amounting to £11 10s. od.

IX. *Movements of Population suggesting possible transmission of Virus*

See Section II, paragraph VII.

In addition to movements of population indicated in Section II there is a large canoe traffic between Warri and various parts of the Niger Delta.

X. *Conclusion*

The infection of the first patient attacked, case L. 26, appears to be definitely associated with the large number of mosquitoes present in the store in which he worked in the evening mentioned in the introductory paragraph to this section. He may have become infected either while at work in this store or on the occasion when he slept on his verandah without a mosquito net.

There had been no suspicious European cases in Warri previously, and the two native cases quoted in paragraph V had occurred fourteen months earlier.

It will be seen (Section II) that no suspicious cases of fever had occurred at this time in Europeans at Forcados or Burutu, the stations with which Warri is most largely in communication.

I took occasion also to visit and examine the records at the towns in the surrounding country where Medical Officers are stationed, namely:—Sapele, Agbor, Benin, Onitsha, and Aboh. The Medical Officers at these places attend Europeans in their respective districts, and cases of illness are recorded in the hospital books. No cases were recorded as suspicious at any of these stations, but at Sapele a death (European) of an undetermined nature had occurred on a steamer in January, 1913 (Section III, Group B, Case 6). No connexion can, however, be traced between this and the Warri cases.

I carefully examined the available notes of blackwater fever cases at the above stations, but there is no reason to suppose that any confusion had arisen in the differential diagnosis of this disease and yellow fever. Cases of blackwater fever occurred as follows:—

	1911.	1912.	1913. (January to October)
Onitsha	—	2	1
Aboh	—	—	—
Benin	1	1	—
Sapele	4	3	1
Agbor	—	—	—

Attention should here also be drawn to a case at Silooko on the Sapele-Lagos mail-launch route (see under Case 8, Group B, Section III), and to the cases that had occurred on various ocean-going steamers (Section III), two of which had called at Warri. There is, however, no apparent connexion between these cases and the Warri outbreak. It may thus be concluded with some probability that the first patient did not receive his infection from a European source. On the other hand, the facilities for conveyance of *Stegomyia* to the premises of the firm in question by water transport are, as has been shown, considerable, and there is always the possibility of the infection having been so conveyed by a mosquito infected from some distant European case which had escaped recognition. This possibility becomes the greater if it be conceded that *Stegomyia* may transmit their infectivity to the first generation. But the likelihood of the infection having been acquired from a native source, particularly in view of the cases which were occurring at that time at Burutu and Forcados (Section II) appears to outweigh these possibilities. The slight ambulatory character which the disease may assume in natives, as illustrated in many of the Burutu, Lagos, and Forcados cases, and the significant fact that the patients who applied for treatment were also exclusively males, makes it practically certain that there are numerous instances in which patients do not seek hospital advice and constitute a source of grave danger to the European community. This danger must be considerable in the absence of European segregation and is emphasized in the case of mercantile firms who shelter numerous natives within their compounds (about forty in one firm's enclosure). Any increase of *Stegomyia*, the possibility of which under existing conditions must be ever present, would then, in the proximity of native reservoirs of infection,

become a serious menace. The practical result of these inferences would appear to be illustrated in the cases under consideration. As shown in the introduction to this section, the second patient's illness was almost certainly secondary to that of the first.

Section II

Introduction.—This section deals essentially with certain cases of fever among natives which occurred during the first eleven months of 1913* in the ports of Forcados and Burutu.

Reference is also made to a case (native) in 1911, and to four cases (Europeans) in 1909.

The European cases were reported by the Medical Officer, Forcados, to the Principal Medical Officer as possible instances of seven-day fever. He also reported as 'unclassified fever' the native case of 1911, and the greater number of the 1913 native cases, but on examining the Forcados records I thought it desirable to include some further cases which present features of interest.

The notes of all the native patients are included in paragraph 5, and, in order to secure a certain degree of uniformity, they have been edited to some extent.

I have included in this section a synopsis and tabular statement of the cases, as they constitute a well-defined group.

I. *General Description of Forcados District and the Ports of Forcados and Burutu*

(*a*) *Forcados District*

Boundaries:—

On the north by Sapele District.
On the east by Warri District.
On the south by Brass District.
On the west by the sea.

Area:—

925 square miles.

---

* With the exception of one case, which occurred at the end of November at Forcados, and is not included here.

Total population, 37,657.

Comprised of:—

Natives of West Africa, 37,171.
Europeans, 480 (396 of these were on ocean boats).
Asiatics, 1.
Other non-West Africans, 5.
Average density of native population per square mile, 40·18.

Census, 1911.

(*b*) *Forcados Port*

The port is situated within the mouth of the Forcados river (one of the estuaries of the Niger), on its left bank, about five miles from the sea.

It is one of the principal places of call for ships in Southern Nigeria. The draught on the bar is sufficient at high tide to enable ocean liners of moderate size to enter the river. It stands upon a flat area of partially reclaimed swamp, which is drained by intersecting shallow tidal ditches. In the wet season the greater part of this area is water-logged, and many of the houses, both European and native, are built upon piles.

The paths are artificially raised.

Encroachment from the water is prevented by a concrete wall.

Area:—

Approximately 200 acres.

Total population, 3,189.

Comprised of:—

Europeans, 42 (officials 25; non-officials, 17).
Natives and other coloured races, 3,147.

Census, 1911.

(There is also a variable floating population—upon steamers in the river—not included in the above figures).

The native population consists mainly of Government officials and employees, and the employees of mercantile and shipping firms. There are two native villages in the vicinity, the nearest of which is approximately one furlong from a European residence.

There is no declared European reservation; indeed, several houses occupied by European officials were at the time of my investi-

gation—and some still remain—in close proximity to native dwellings. Thus certain sheds (since abandoned) occupied by native boatmen with their wives and children were situated at a distance of only 120 yards from the District Commissioner's house, while they were within 90 yards of the Senior Marine Officer's house and the quarters of some other European officials and practically adjoined the Rest House, which is used as permanent quarters.

As is to be expected, under these circumstances, even less attention is paid to the question of European segregation among mercantile firms. Thus in one compound inspected by me there were housed 151 natives (36 Kroo boys and 115 natives of Nigeria) within a relatively short distance of the offices and living rooms of the European staff.

(*c*) *Burutu Port*

The port is situated about five miles to the east of Forcados on the same bank of the river. The area of ground which it occupies is, for the most part, sand-bank, the remainder being reclaimed swamp, which is similarly drained and protected to Forcados.

The port is an important place of call for ocean liners, which here, in contra-distinction to Forcados, moor alongside the wharves. At the latter place they, for the most part, anchor in the river.

Area :—

Approximately 45 acres.

Total population, 1,514.

Comprised of :—

Europeans, 20 (officials, 3; non-officials, 17).	Census, 1911.
Natives and other coloured races, 1,494.	

(There is also a variable floating population—upon steamers in the river—not included in the above figures).

The native population consists mainly of Government officials and employees, and the employees of the Niger Company. There is no European reservation; indeed, the quarters of the Marine Officers are only approximately 100 yards from the house occupied

by a native official and from a shed where native passengers by river-boat are allowed to pass the night when necessary.

In both Forcados and Burutu, the water supply is obtained in the case of Europeans from screened rain-water tanks, in the case of natives also to a great extent from wells and water-holes.

II. *Rainfall and Temperature*

In Appendix IV will be found a record of the monthly rainfall, together with maximum and minimum shade temperatures during 1911, 1912, and the first eight months of 1913.

It will be seen that (as the weather conditions are practically identical in Forcados and Burutu) these conditions do not appear to have exercised any special influence on the incidence of the cases recorded for 1913, since those at Burutu occurred between January and July only, whilst those at Forcados occurred exclusively from April onwards. Cases which did not seek the Medical Officer's advice *may*, of course, have continued to occur at Burutu after July, just as they *may* have occurred at Forcados before April. I would suggest that epidemics of disease connected with domestic mosquitoes may probably be more closely allied to conditions of water-storage than to seasonal incidence and that the influence of the latter is felt indirectly through its effect upon the former.

III. *Any Recent (Suspicious) High Mortality amongst Natives at Forcados and Burutu, especially Native Children*

The Medical Officer told me that no exceptional mortality had come under his notice. The District Commissioner informed me further that registration of deaths is quite unreliable, the natives being very reluctant to give information, so that practically the only cases registered are such as come directly under official notice (e.g., the Coroner's inquest). My interrogation of the representative Chiefs of the two ports was with an entirely negative result.

IV. *Number of Europeans in Forcados and Burutu, and Suspicious Cases of Fever among them within the last Twelve Months*

The number of Europeans resident in Forcados and Burutu at the time of my investigation was 56. There were no Syrians living at either port. The number of cases of malaria in Europeans

treated in 1911, 1912 and 1913 (to the end of November) was respectively 29, 53 and 38. There were no cases of haemoglobinuric fever during these years.

I examined all available records and found that there had been no suspicious cases of illness in Europeans since 1909. I do not here take into account certain cases of fever which occurred on ocean-going steamers, some of which were actually at Forcados at the time, whilst others had touched there. These are discussed in Section III.

Out of the 56 residents, I found that three had lived in regions where yellow fever is endemic before coming to West Africa. I was informed by one of these that he had contracted the disease about seventeen years ago at Santos (Brazil), but he was unable to recollect any details of the illness.

In view of a perhaps previously acquired immunity, I have collected the figures which, for the sake of clearness, are appended in tabular form (Table No. 1), from which it will be seen that, provided prolonged residence in an endemic zone, without long intermissions in regions non-endemic, confers immunity (as having passed through an attack of the disease is said to do), then the three residents mentioned in the table must be insusceptible. From the same point of view, a table (Table No. 2) is appended, of the remaining 53 residents. The following are copies of the notes and charts of four cases of fever in Europeans which occurred in Forcados in 1909. Nos. 1, 2 and 3 were reported to the Principal Medical Officer as possible cases of seven-day fever and I have included them all here, not only because they present features of great interest, but also because seven-day fever forms one of the subjects of inquiry of the Yellow Fever Commission.

Dr. Bailey, Medical Officer at Forcados, in the prefatory note to his report on some cases of unclassified fever (1913) says:—

> 'The three cases, Nos. 1, 2 and 3, I reported at the time and suggested that they were cases of seven-day fever as described by Leonard Rogers in his "Indian Fevers."
>
> 'The notes were incomplete, but I got enough to establish:
>
> '*In all*: The temperature chart with double rise.
>
> '*In two cases*: Violent loin pain and slow pulse (as far as

it went). A prostration too great for the temperature. A recovery free from relapses.

'One case—No. 2—had a profuse rash. Case 4, which ended in death, could not have been seven-day, even if the others were, as Rogers says no fatal case has been known. His temperature rose to 105° on third day, remitted a little and then rose to 105° again on the fifth day. Urine was unfortunately not examined. Death occurred on the sixth day after most violent mania and convulsions (at that time one only considered malaria and sun). This case is given because it must bear on the other three, although I hope it is not the same.'

I would here remark that in Cases 2 and 3, in which the urine was examined, there was no albuminuria on the third day of the disease and it was not subsequently tested for. Albuminuria, in cases of yellow fever, may, of course, occur later.

TABLE No. 1

Number	Number of years resident in an endemic area other than West Africa	Period between residence in an endemic area and first coming to West Africa. (Interval of residence in a non-endemic area)	Number of months in West Africa since last in Europe	Number of months in Forcados or Burutu since last in Europe	Number of months in other parts of West Africa since last in Europe	Number of months in West Africa (not including leave) since first coming to West Africa
1. Government official	28	2¼ months	12	12	—	119
2. " "	27	3 "	4	4	—	95
3. " "	3	5 "	5	5	—	157

NOTE.—No. 3 is said to have suffered from yellow fever about seventeen years ago at Santos (Brazil).

Table No. 2

Number	Number of months in West Africa since last in Europe	Number of months in Forcados or Burutu since last in Europe	Number of months in other parts of West Africa since last in Europe	Total number of months resident in West Africa since first coming to West Africa (not including leave)
1. Government official...	5	5	—	123
2. ,, ,, ...	9	3	6	24
3. ,, ,, ...	4	4	—	101
4. ,, ,, ...	1	1	—	27
5. ,, ,, ...	9	3	6	81
6. ,, ,, ...	5	2	3	36
7. ,, ,, ...	5	5	—	5
8. ,, ,, ...	3	3	—	27
9. ,, ,, ...	6	6	—	32
10. ,, ,, ...	8	4	4	68
11. ,, ,, ...	8	2	6	20
12. ,, ,, ...	6	6	—	42
13. ,, ,, ...	1 week	1 week	—	36
14. ,, ,, ...	3	3	—	3
15. ,, ,, ...	11	11	—	103
16. ,, ,, ...	2 weeks	2 weeks	—	39
17. ,, ,, ...	6	2	4	82
18. ,, ,, ...	11½	11½	—	85½
19. Non-official	8	8	—	48
20. ,, ...	10	10	—	35
21. ,, ...	4	4	—	42
22. ,, ...	7	7	—	62
23. ,, ...	11	10	1	62
24. ,, ...	10	10	—	59
25. ,, ...	2 weeks	2 weeks	—	210
26. ,, ...	6	6	—	51
27. ,, ...	9	9	—	21
28. ,, ...	2	2	—	2
29. ,, ...	5	5	—	64
30. ,, ...	4	4	—	56
31. ,, ...	10	6	4	10
32. ,, ...	17	13	4	42
33. ,, ...	26	6	20	26
34. ,, ...	15	15	—	360
35. ,, ...	2	2	—	24
36. ,, ...	2	2	—	2
37. ,, ...	13	13	—	48
38. ,, ...	12	12	—	33
39. ,, ...	13	13	—	192
40. ,, ...	13	13	—	144
41. ,, ...	2	2	—	20
42. ,, ...	2	2	—	2
43. ,, ...	13	13	—	84
44. ,, ...	14	14	—	38
45. ,, ...	16	16	—	16
46. ,, ...	7	7	—	53
47. ,, ...	15	15	—	45
48. ,, ...	17	17	—	17
49. ,, ...	8	8	—	92
50. ,, ...	1	1	—	21
51. ,, ...	12	12	—	51
52. ,, ...	4½	4½	—	64½
53. ,, ...	2	1 week	1¾	91

F

Case 1. L. 7†

Copy of Notes by the Medical Officer, Forcados

Race: European.
Age: —
Occupation: Foreman.
Date of illness: October, 1909.

This was a case of 'fever' returned as malaria, which occurred one month before cases 2 and 3 and before the death, at which both men assisted. When making a report on them, I turned up also this chart of a case which had worried me, because quinine, although absorbed, had no effect at all on the disease.

It shows very well the double rise of temperature, and I consider it to have been a case of the same kind.

The pulse was not recorded in this case, as I was thinking of nothing but malaria.

Case 2. L. 10†

Copy of Notes by the Medical Officer, Forcados

Race: European.
Age: —
Occupation: Foreman.
Date of onset: 22nd November, 1909.
Date of recovery: 29th November, 1909.

23rd November.—Seen to be ill in the evening. Illness stated to have begun the day before. Patient had just assisted at death of a brother foreman from a disease characterized by continuous high temperature and mania at last.

Patient was too ill for his temperature—great prostration—dirty tongue—violent pain in the back.

A vivid rash, like rubella, appeared on 23rd, becoming faintly papular (never vesicular) on wrist and ankles—forehead and neck deeply flushed—face clear.

No catarrhal symptoms—no glandular enlargement.

Second rise of temperature on fifth day, with return of symptoms in less degree. Slight bilious vomiting occurred once. No jaundice. Quinine was given on second day, then reduced to 5 grs. daily, as case obviously not malarial.

Urine on third day: No albumen.

Pulse was 55 with normal temperature on seventh day, unfortunately not counted before.

In view of:—

1. The fact that case was obviously not malarial;
2. The double rise of temperature;
3. The duration;
4. The violent loin pain;
5. The slow pulse;

I suggested in reporting the case that it much resembled cases described as seven-day fever in India by Rogers and others.

It is a great pity, of course, that there is not a better record of the pulse. Second hands do not always abound in outstation out-patient practice, and I did not consider the possible great importance of a pulse count till late in the case.

The rash persisted for some weeks and left stains.

Convalescence was slow but sure.

No relapses or joint or bone pains.

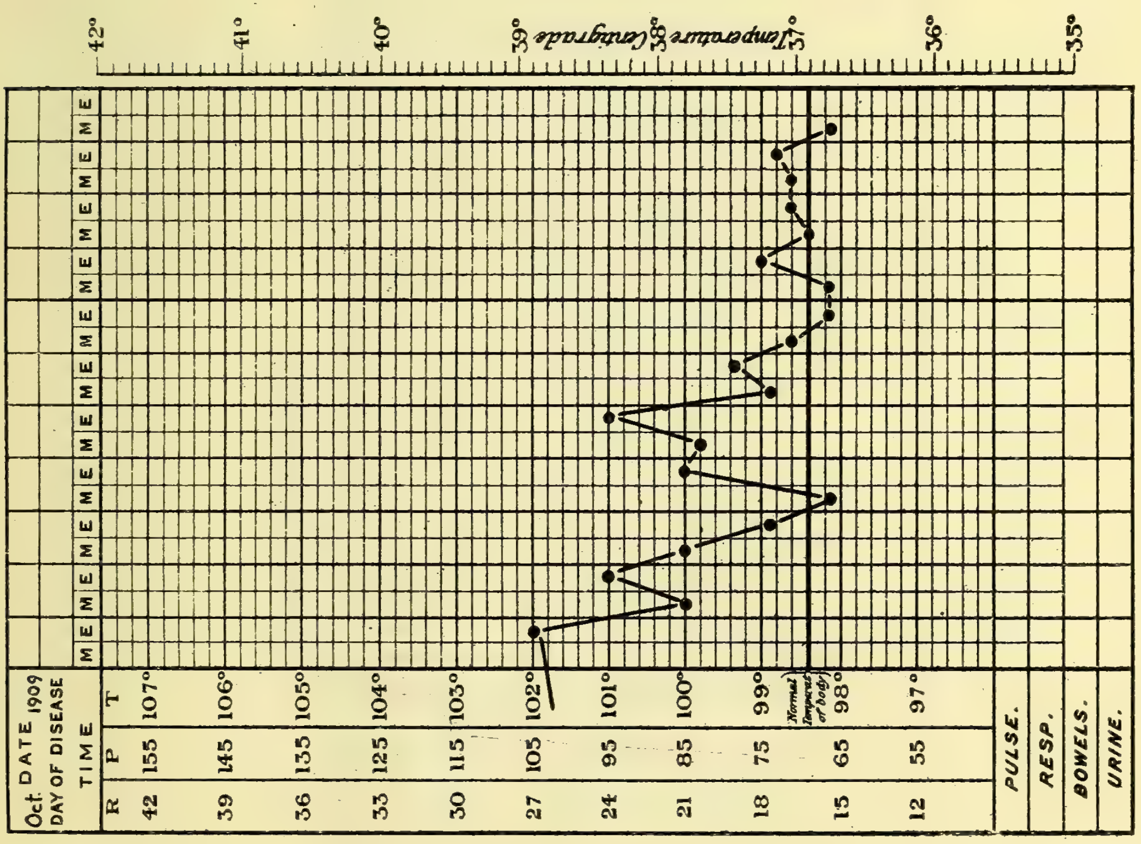


Chart 13. Case 1

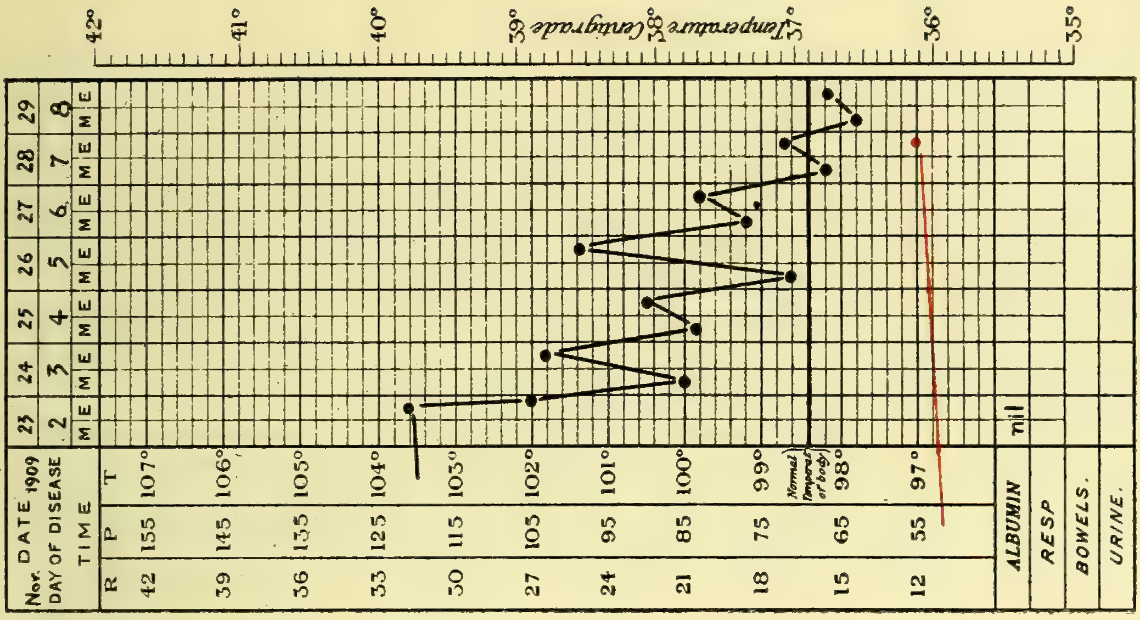


Chart 14. Case 2

CASE 3. L. 9†

Copy of Notes by the Medical Officer, Forcados

Race: European.
Age: —
Occupation: Foreman.
Date of onset: 23rd November, 1909.
Date of recovery: 1st December, 1909.

24th November.—First seen on second day of fever. All symptoms were the same as those in Case 2, but slighter, except the loin pain, which was very severe.

The rash was very slight, and, although distinct enough, the few patches in which it occurred would not have been seen unless specially looked for.

The second day rise of temperature was very well marked, and with it the exacerbation of symptoms.

Patient again was much too ill for his temperature.

Pulse was counted earlier this time, while there was still some fever, and was slower.

The same diagnosis was suggested. Quinine was not used after the first day.

Patient had assisted at same death as last patient.

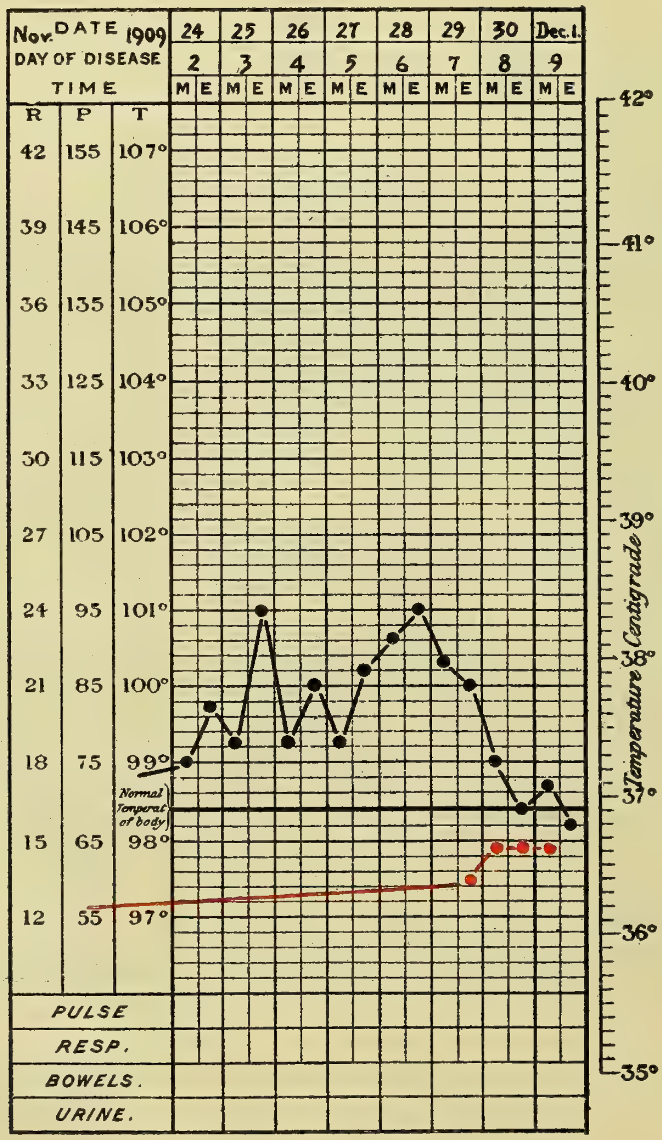


Chart 15

Case 4. L. 8†

Copy of Notes by the Medical Officer, Forcados

Race: European.
Age: —
Occupation: Foreman.
Date of onset: 16th November, 1909.
Date of death: 21st November, 1909.

16th November.—Felt seedy, but worked apparently with temperature till 18th November, when fever reached 105° in the evening.

Temperature dropped to 103°-104° next day, and rose on 20th November to 105° again.

On the night of the 20th there was merry delirium—giving way to ice as temperature fell to nearly 100°. Then, in morning of 21st, violent mania followed by convulsions supervened and patient died.

Urine: Not examined.
Chief trouble: Headache.
Two slight bilious vomits.
No haemorrhages.
Returned as a death from malaria.
No post-mortem.

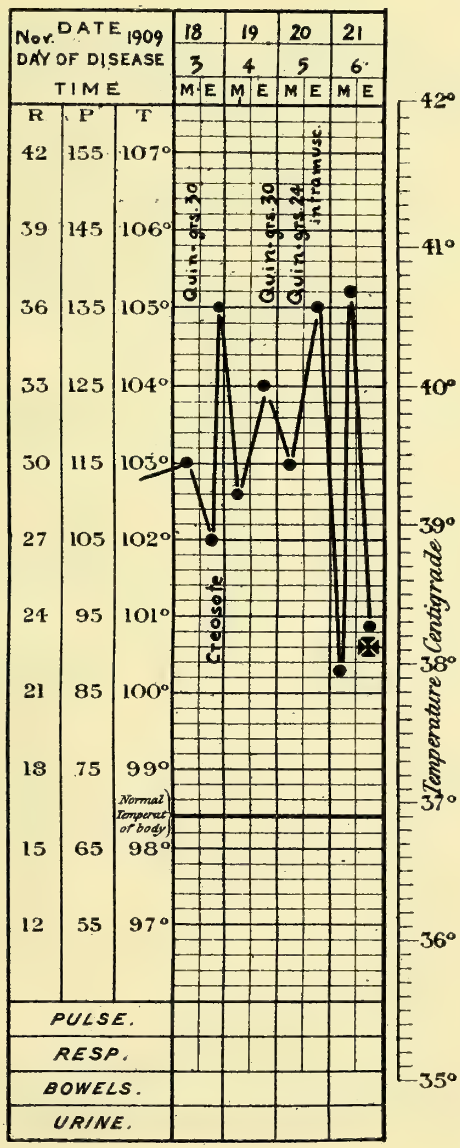


Chart 16.

V. *Prevalence at Forcados and Burutu of suspicious cases of fever among Natives*

I examined all the hospital and post-mortem records of these stations.

In 1911, 1912 and 1913 (to the end of November), 213, 368 and 388 cases respectively of malarial fever in natives were treated. The records of these cases present no anomalous features with the exception of one in 1911.

From the third week in January, 1913, up to the time of my inquiry (November) a number of suspicious cases had occurred. These are not included in the 388 cases diagnosed as malaria, treated during that period. The following are copies of the notes and charts of these suspicious cases, including the one of 1911. (Nos. 1, 2, 3 and 4—the European cases—have already been dealt with in paragraph IV.)

Preceding the notes is a copy of Dr. Bailey's cover to his half-yearly return of suspicious cases, January to June, 1913, and a copy of his report written in April on some cases of unclassified fever at Burutu during the first four months of 1913.

I have compiled and appended to this collection of cases, which is complete, with the exception noted in the introduction to this section, up to the end of November, 1913:—

(i) A tabular statement of the cases (European—paragraph IV—and native).
(ii) A synopsis of the cases (European and native).
(iii) Two 'spot' maps (Forcados and Burutu) of the 1913 cases.
(iv) A note in regard to the movements, previous to admission, of Nos. 6, 20, 21, 25, 28, 31, 35, 39, 46, 47, 48, 52 and 53—the only cases of the 1913 series who are known to have been away from Forcados or Burutu shortly before their illness.
(v) A clinical note.
(vi) An epidemiological note.

It may reasonably be supposed that the cases here described represent only a proportion of those actually sick, and, in this

connexion, it is significant that with one exception all the patients were males and none were children below the age of twelve.

In considering them I would draw attention to the fact that the chart records were made, for the most part, by a native dispenser or dresser. Experience has shown that the records of temperature, albuminuria and bowel actions may be accepted as correct, those of pulse-readings and reaction of urine as probably correct (it will be seen, however, that some of the pulse-readings are difficult of acceptance), those of the total quantity of urine excreted and of its specific gravity as mostly incorrect. These latter are, therefore, not referred to in the synopsis. The records of respirations are very unreliable and I have accordingly omitted them from the charts, except in two cases—Nos. 14 and 15: the patients were suffering from pneumonia and the records are given for what they may be worth.

Copy of Dr. J. C. M. Bailey's Cover to Half-Yearly Return of Suspicious Cases: January—June, 1913

All were characterized by:—

1. Being obviously non-malarial.
2. Albuminuria.*

Many had:—

1. Characteristic double rise of temperature.
2. Slow pulse.

Some had:—

1. Injected eyes.
2. Red tongue with white fur.
3. Enlargement of liver and spleen.
4. Deafness.
5. Slow convalescence.

None had vomiting or any apparent abdominal disturbance.† The fatal case classed with them had coffee-ground vomit and malaria post-mortem. Jaundice in slight degrees was not accepted as it is almost the rule in healthy persons.

* Cases 26, 37, 38, admitted after June, had no albuminuria.—E.J.W.

† There was vomiting in cases 39, 47, 51, admitted after June.—E.J.W.

Copy of Report by Dr. J. C. M. Bailey, written in April, on some Cases of Unclassed Fever Occurring at Burutu during the First Four Months of 1913.

Since the beginning of this year I have been called on to treat a number of cases of fever, mostly of a pretty severe type, which cannot possibly be passed under any of the usual headings.

All these cases have occurred at Burutu. They can, I think, be divided into two distinct classes—Class A and Class B. There seems to be a tendency to the occurrence of an epidemic of Class B at the present time.

I am returning with Class A a report on a case of fever in a native policeman here in August, 1911, which I then returned as fever undiagnosed and later sent in as a 'suspicious' case on the ground that anything not malarial was suspicious.

Class A consists of two cases (Nos. 6 and 7*): A. (No. 6) admitted 22nd January, and J. (No. 7) admitted 19th February.

Both were characterized by:—

1. Very great prostration.
2. Albuminuria.
3. Very slow convalescence.
4. No parasites.
5. No vomiting or jaundice.

They very much suggested clinically that they were of the same type as case No. 5, August, 1911, attached to them.

It is not easy to be certain about the type of temperature. I know that I caught No. 5 on the second day and I think No. 7 not later than the third, but No. 6 gave a long history and I supposed that he might possibly have been an enteric. I don't think so, but my experience of that disease is not extensive. He was constipated throughout his stay in hospital and took purges regularly. There was no enlarged spleen and no flatus. I have no diagnosis to suggest for these fevers.

Class B consists of the following:—No. 9 admitted 4th March; No. 10 admitted 4th March; No. 11 admitted 4th March; No. 12 admitted 5th April; No. 13 admitted 8th April.

---

* The cases are numbered by me for convenience of reference.—E.J.W.

All these cases are not malaria.

They are characterized by:—

1. Albuminuria.
2. Slow pulse.
3. An absolutely typical temperature chart seven to nine days' long showing a perfectly clear double rise.

In several there has been:—

4. Injection of the eyes.
5. Thick white fur on dorsum of tongue.
6. Deafness of varying degree.

The blood, where examined, has been negative and in one case—No. 9—where quinine was accidentally given throughout, the disease was absolutely unmodified.* There has in no case been any vomiting or tendency to it.

Some of the cases have been severe and the patient evidently very ill. Others fairly slight, but even then there is considerable apathy noted and only in one case—No. 10—did the patient protest he was well, and he was obviously scared of being in hospital and upset at the milk diet with which I started him.

The deafness is interesting.

I have had a death a day or two ago, which I am returning as from otitis media (Case 8). In this case prolonged and profuse suppuration was apparently the cause of the patient gradually sinking after his temperature, which was very high and irregular for three weeks, had subsided. It has occurred to me that this otitis may have been the result of an attack of the fever I am describing. The patient had albuminuria. No post-mortem.

For the Class B fever I have again no diagnosis to offer. The chart is very like seven-day fever and the slow pulse also, but the loin pain described by Rogers has not been forced on one at any date and what pains do occur are, I think, fairly attributable to the temperature—Class B fever will do for a name for the present.

In none of my unclassified fevers has there been any digestive trouble, *e.g.*, vomiting—*or any haemorrhagic tendency at all.*

---

* Quinine was also given in cases 38, 40, 42, 43, and 50, admitted in October. With these five exceptions also none of the patients received quinine.—E.J.W.

CASE 5. L. 6†

Race: Negro.
Age: —
Sex: Male.
Occupation: Water-policeman.
Date of admission to hospital: 26th August, 1911.
Date of discharge: 4th September, 1911.

A case returned in first return of suspicious fever as a case possibly of yellow fever.

Characterized by:—

Great prostration.
Foul tongue.
Injected conjunctivae.
Cloud of albumen in urine on fourth day—disappearing later.
No vomit.
Liver somewhat enlarged—tender.
No jaundice.
Pulse rate slow for temperature and pulse weak.
No special pain, back or otherwise.
No parasites in blood.

Convalescence was slow, and patient remained weak and apathetic for some considerable time.

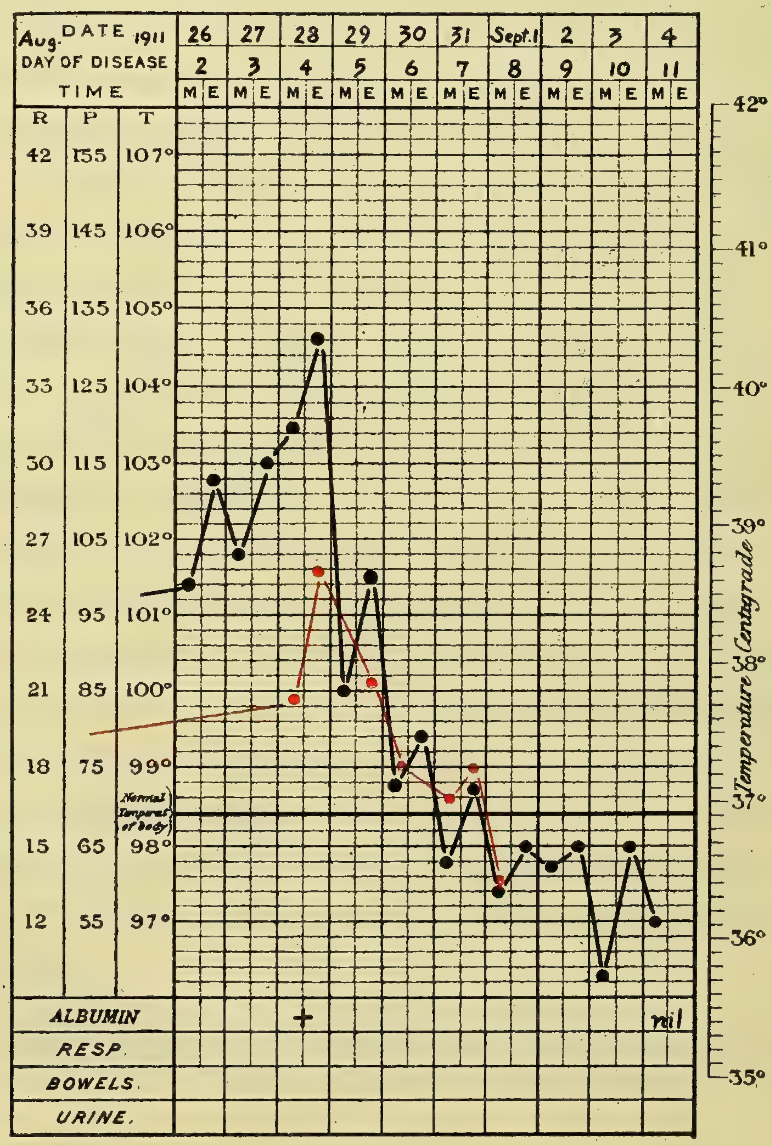


Chart 17.

CASE 6. L. 11†

Race : Negro.
Age : 30.
Sex : Male.
Occupation : Engineer.
Date of admission to hospital : 22nd January, 1913.
Date of discharge : 13th February, 1913.
History.—Of three weeks' fever.

Condition on admission.—Admitted *very prostrate*—wasted. Temperature 105° Fahr. Pulse 120. Eyes—no jaundice. No vomiting. Liver slightly enlarged and tender. Chest, some natural râles. Urine, no albumen ; bilious appearance, but nitric acid test negative. Blood, negative.

Course : 30th January.—Cloud of albumen appeared in urine and remained till 4th February.

27th January.—Patient began complaining bitterly of burning pain in soles of feet. This symptom persisted after discharge. Knee jerks were present.

The fever took a long time to wear out ; finally after nearly three weeks temperature became sub-normal and of moderate excursion and convalescence started.

The case completed showed a fever *not malaria*, characterized by *great prostration*, albumen in urine, no jaundice or vomiting, pulse rate not helpful, no parasites in blood, a slow convalescence with no relapse.

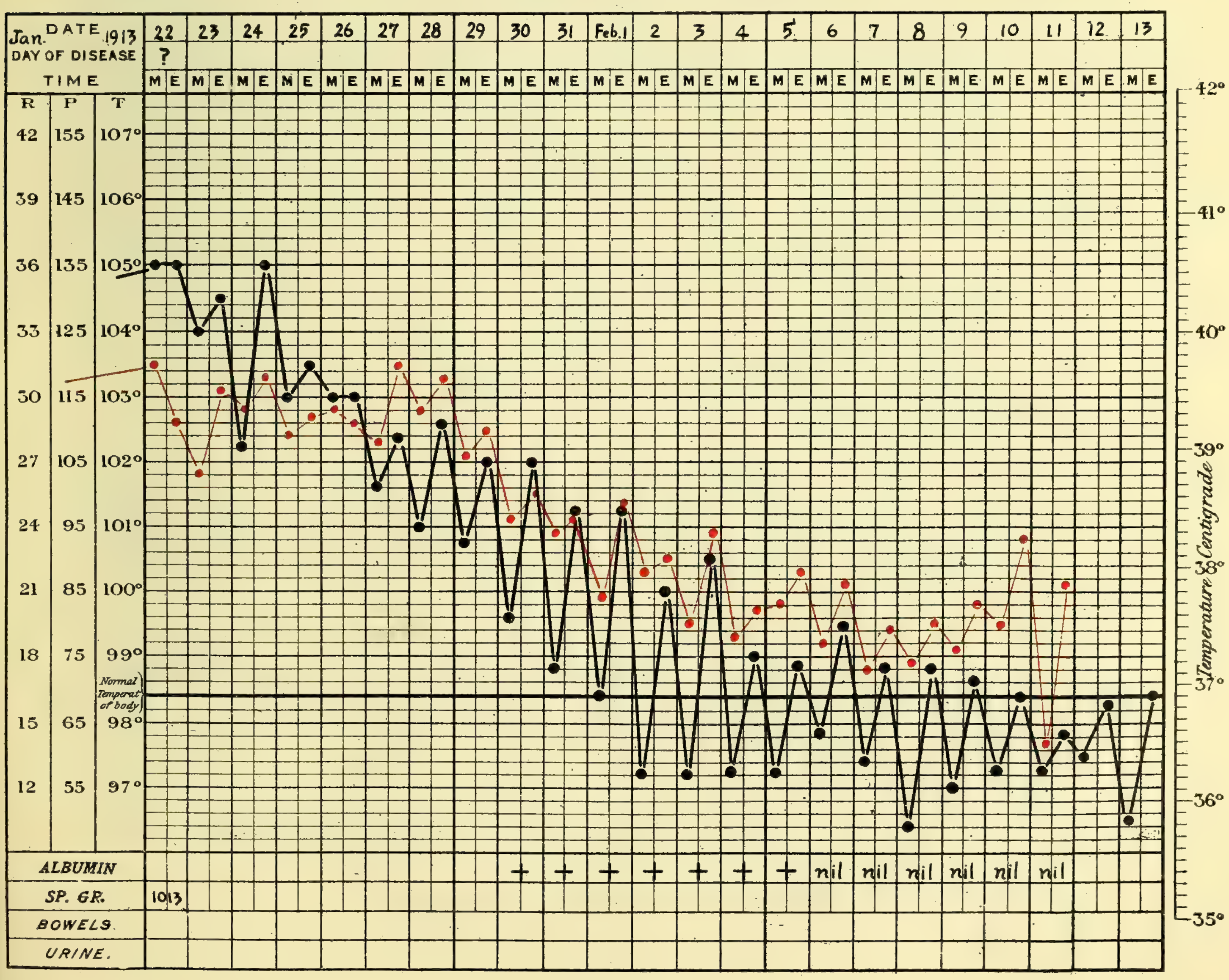


Chart 18.

Case 7. L. 12†

Race: Negro.

Age: 26.

Sex: Male.

Occupation: Labourer.

Date of admission to hospital: 19th February, 1913.

Date of discharge: 18th March, 1913.

History.—One week's illness (doubtful).

Condition on admission and course.—Complained chiefly of pain about shoulders and other joints, and was first put on sod. salicyl. Day after admission urine was found thick with albumen. His tongue was furred. No vomiting. No parasites in blood. Prostration was great, in spite of which he managed to escape from isolation and was not recaptured for four days, when fever was obviously on the decline. Temperature became sub-normal and case dragged slowly on till 18th March, when temperature rose to about normal, and patient, still weak and giddy, was discharged.

The case completed showed a fever *not malarial* (treatment: no quinine) characterized by great prostration, foul tongue, albuminous urine, no jaundice or vomiting, pulse rate not helpful, no parasites in the blood, a convalescence slow and painful, but with no relapse or recurrence of pains.

Case 8

Race: Negro.

Age: —

Sex: Male.

Occupation: Labourer.

Date of admission to hospital: 3rd March, 1913.

Date of death: 11th April, 1913.

History.—

Condition on admission.—Brought in very seedy on a stretcher. Face fallen in. Temperature, 98·6° Fahr. Pulse, rapid. Urine, albuminous. Chest, filled up. Coughing difficult from weakness. No definite signs otherwise made out. Spleen, enlarged and hard; not tender.

Course: 4th March.—Condition about the same. Temperature higher.

10*th March.*—Profuse purulent discharge right ear. Temperature has been running a very peculiar and irregular course. Albumen has cleared up.

20*th March.*—Temperature still very irregular. Discharge very profuse—(? temperature sphenoidal abscess).

1*st April.*—Still very ill. Temperature keeps round normal since 23rd. Patient seems losing ground.

11*th April.*—Died exhausted, apparently by suppuration.

No autopsy.

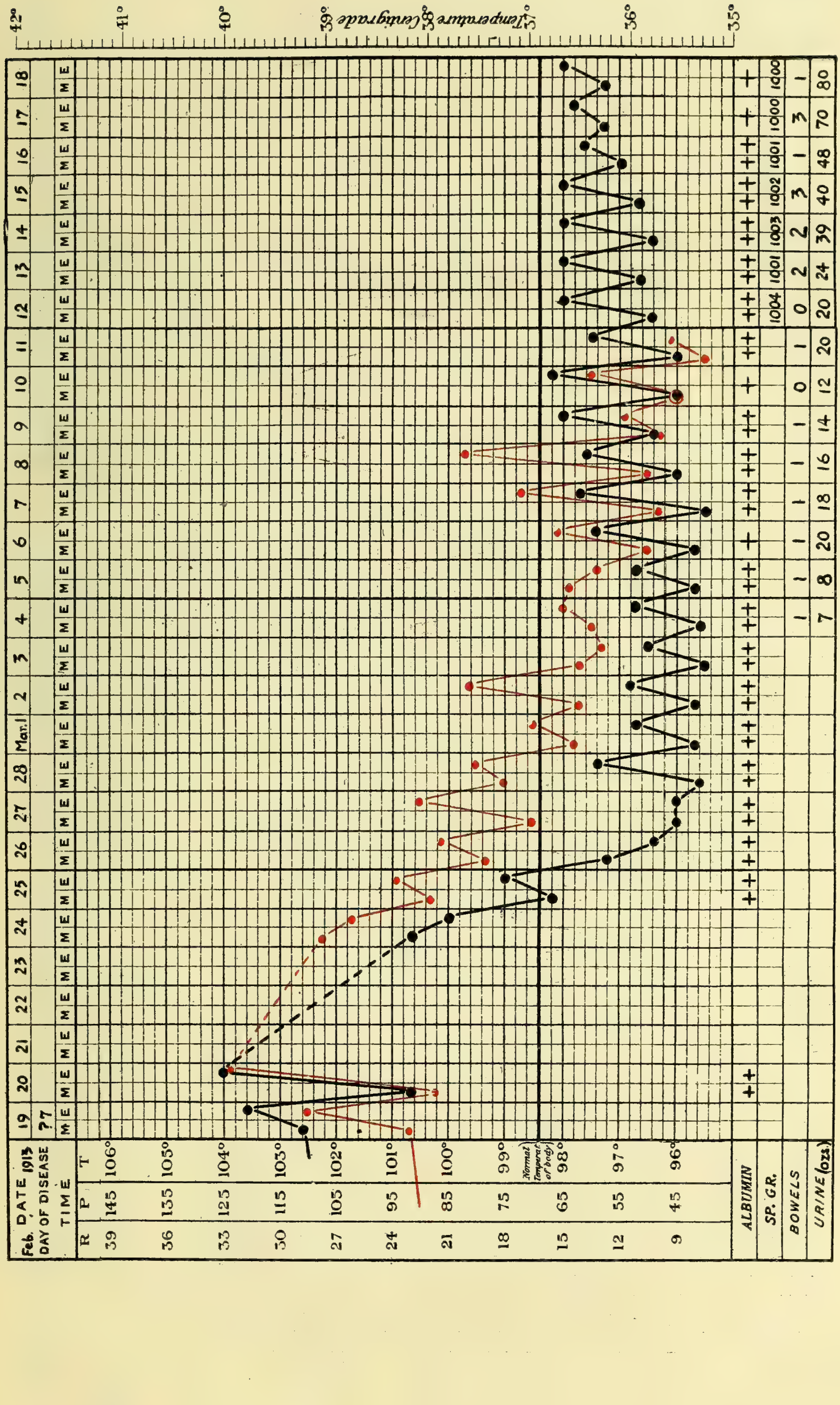


Chart 19. Case 7.

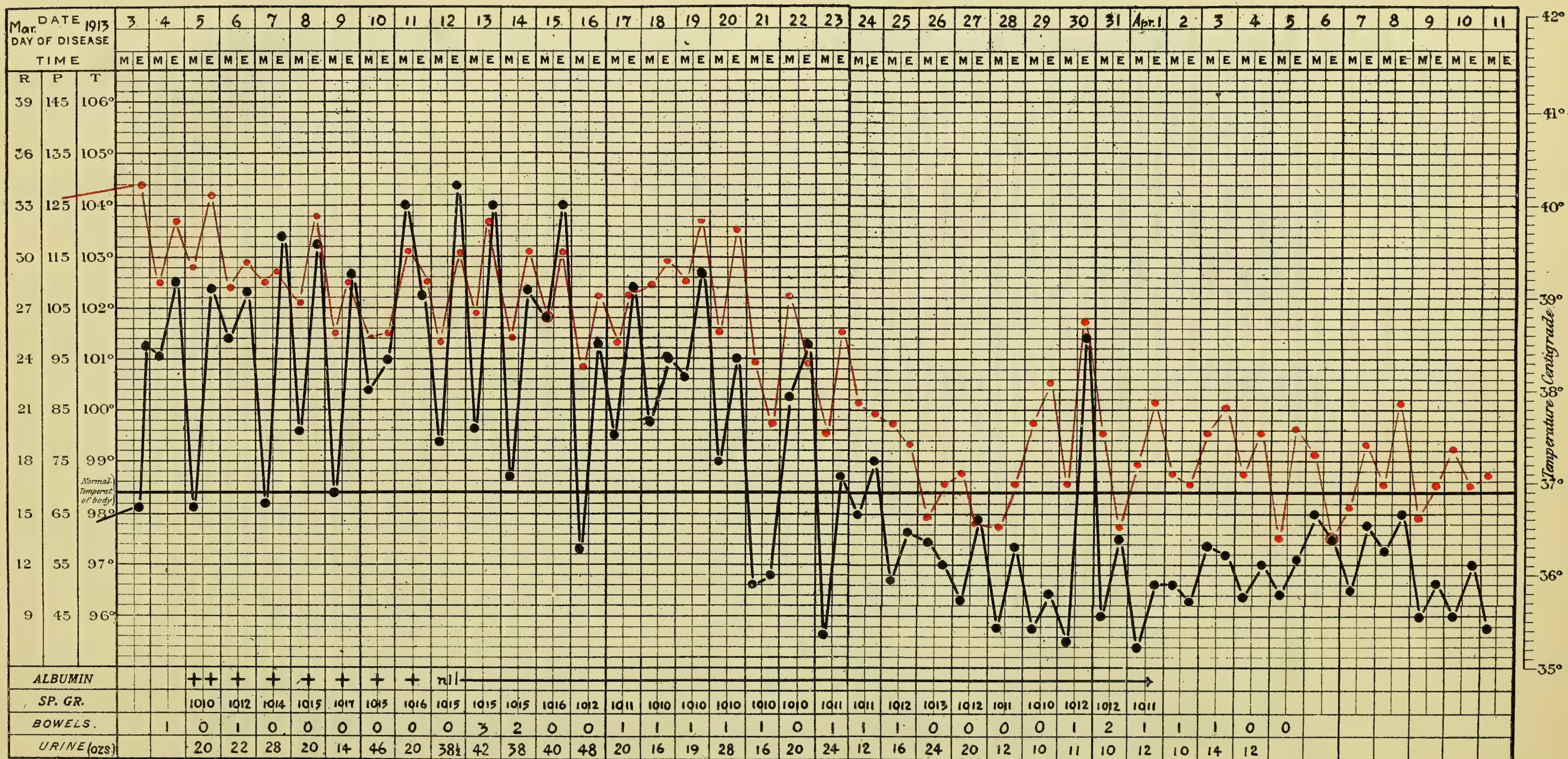


Chart 20. Case 8.

CASE 9. L. 3†

Race: Negro.

Age: —

Sex: Male.

Occupation: Labourer.

Date of admission to hospital: 5th March, 1913.

Date of discharge: 13th March, 1913.

History.—Fever of one week's duration, with pains all over his body.

Condition on admission.—Temperature, 102·4° Fahr. Pulse, 110. Eyes, not injected. Tongue, pretty clean. Complained of pains all over neck, back and arms. Bowels open daily. No vomiting. Abdomen, spleen just palpable on deep inspiration. Blood, negative. Urine, slight cloud of albumen.

Case completed showed a fever not malarial. Albuminuria. Temperature chart of absolutely characteristic type—double rise. Slow pulse.

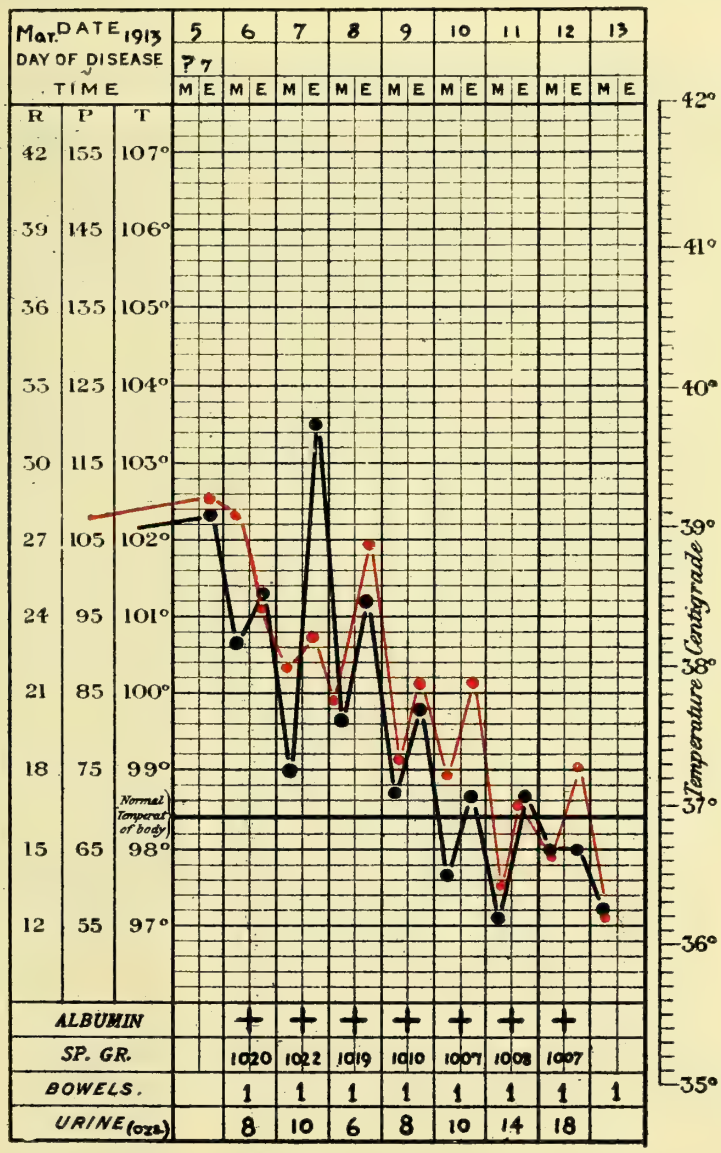


Chart 21.

CASE 10. L. 2†

Race: Negro.

Age: 29.

Sex: Male.

Occupation: Labourer.

Date of admission to hospital: 4th March, 1913.

Date of discharge: 15th March, 1913.

History.—Of seven days' illness.

Condition on admission.—Temperature 103° Fahr. Pulse, 82. Eyes, slight injection; no jaundice. Tongue, coated. Breath, foul. No vomiting. Chest and abdomen, negative. Urine, thick albumen. Blood negative.

Later developed deafness (no quinine given). Case completed showed a fever not malarial, of a fairly severe type, although patient, who was scared of hospital, constantly said he was fit to go.

Albuminuria. Injected eyes. Tongue coated. Deafness. Temperature chart of an absolutely characteristic type, double rise. Slow pulse.

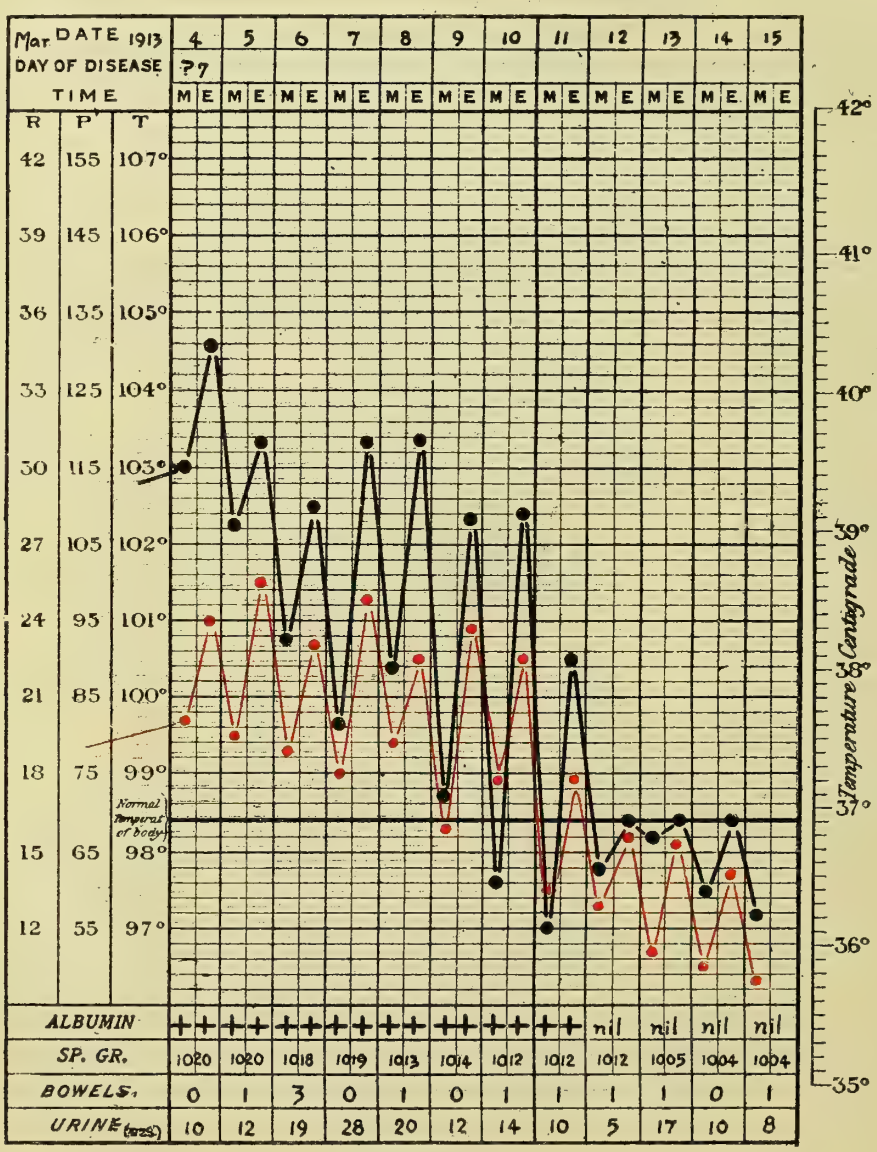


Chart 22

Case 11. L. 1†

Race : Negro.

Age : 26.

Sex : Male.

Occupation : Labourer.

Date of admission to hospital : 4th March, 1913.

Date of discharge : 18th March, 1913.

History.—Three days' illness.

Condition on admission.—Temperature, 100·6° Fahr. Pulse, 92. Eyes injected. Tongue, coated on top ; red at tips and edges. Chest, a few bronchitic signs ; respirations hurried, about 45. Abdomen, negative. Urine, thick albumen. Blood, negative. Later, deafness.

Night of 12th, a renal crisis—70 ozs. urine passed.

Case completed showed a fever, not malarial, of a severe type with albuminuria. Injected eyes. Sharp red tongue coated on dorsum. Deafness. Temperature chart characteristic, double rise. Slow pulse.

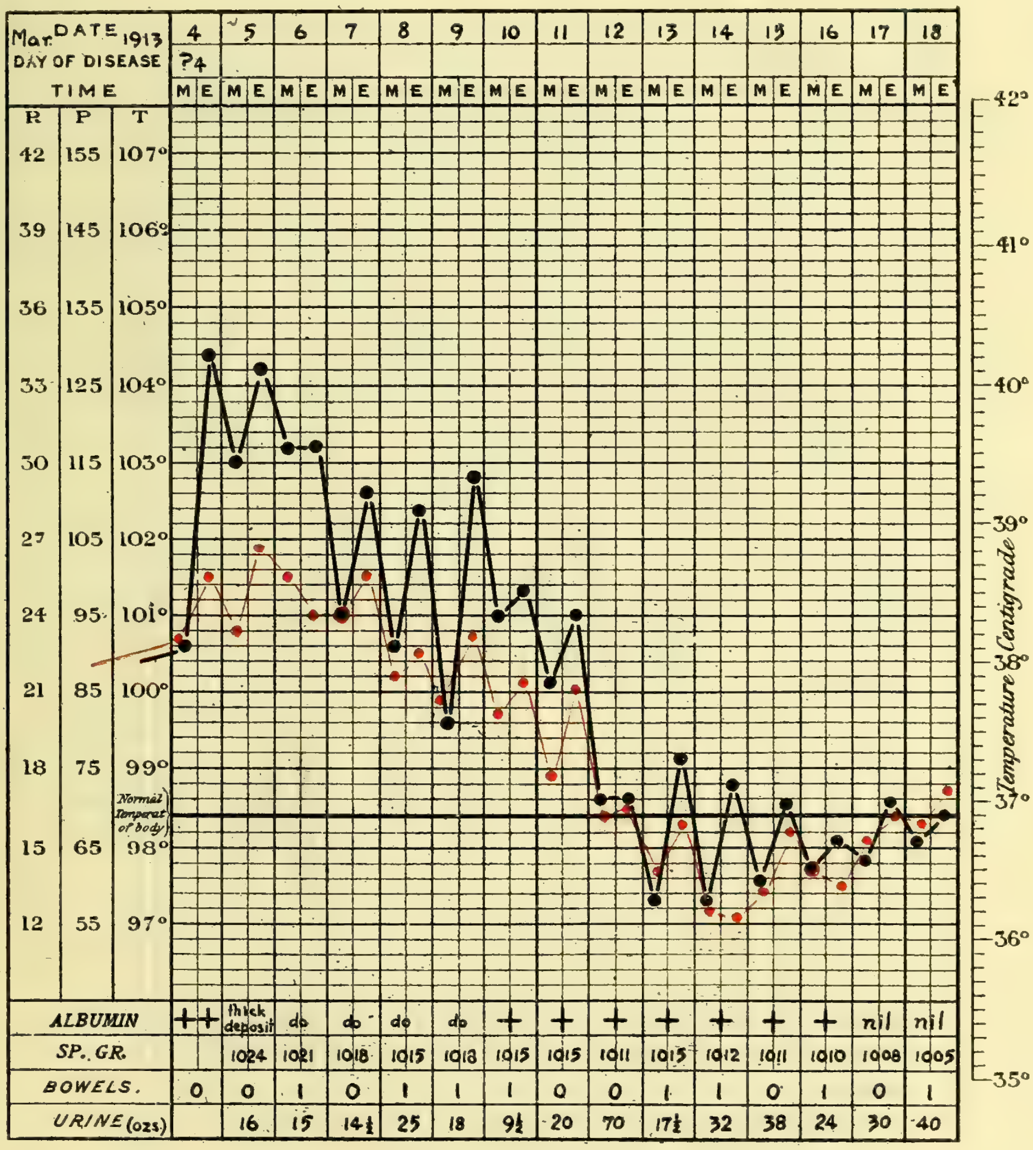


Chart 23

Case 12. L. 4†

Race : Negro.

Age : 18.

Sex : Male.

Occupation : Labourer.

Date of admission to hospital : 5th April, 1913.

Date of discharge : 16th April, 1913.

History.—Five days' illness before admission.

Condition on admission.—Temperature, 103·5° Fahr. Pulse, 122. Eyes, slightly injected. Tongue, bright red with white fur on dorsum. Abdomen : spleen, two fingers below ribs ; liver, two fingers below ribs ; tender. Urine, thick albumen.

Deafness complained of on 10th, but slight.

Case completed shows a fever not malarial, characterized by : Albuminuria. A typical temperature chart. Injected eyes. Red tongue with white fur. Deafness.

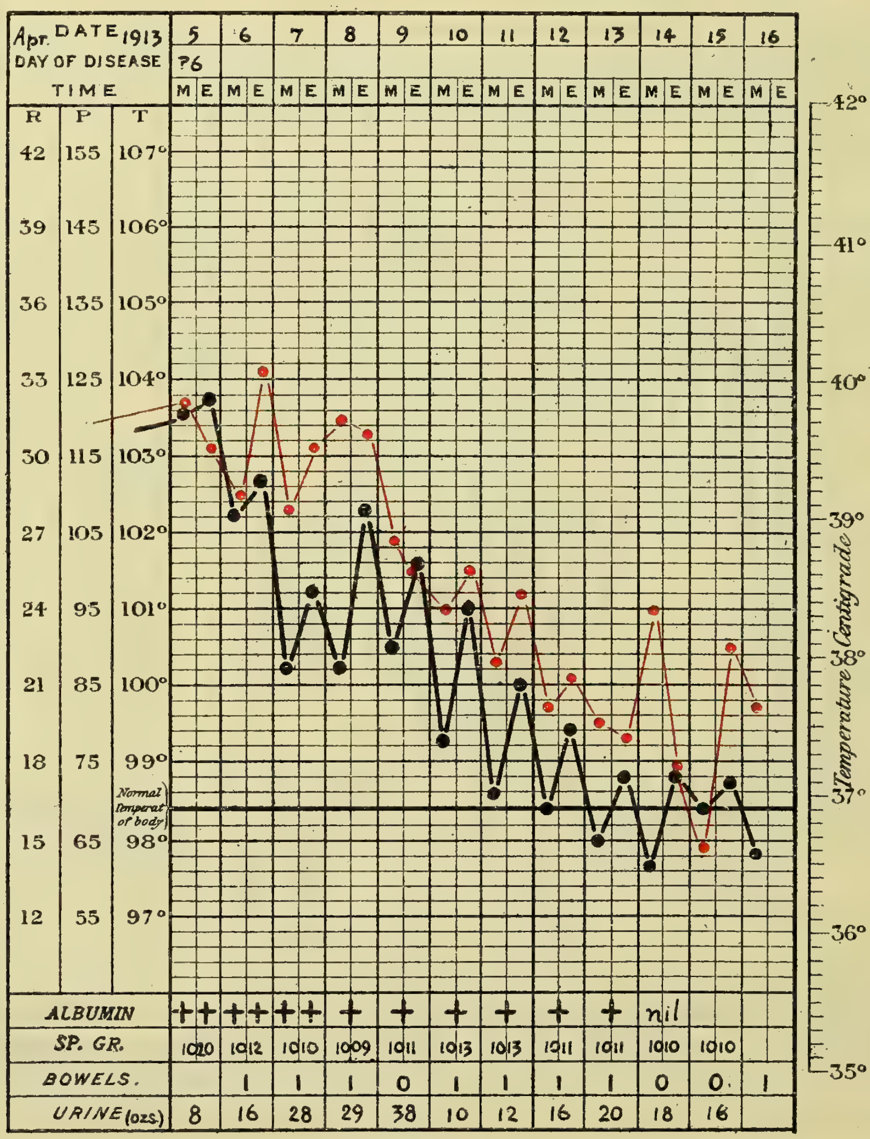


Chart 24

CASE 13. *Commission number not obtainable*

Race: Negro.

Age: —

Sex: Male.

Occupation: Labourer.

Date of admission to hospital; 7th April, 1913.

Date of discharge: 16th April, 1913.

History.—One week's illness—'fever.'

Condition on admission.—Temperature, 101·4° Fahr. Pulse, 100. Eyes jaundiced. Urine, much albumen. Chest, crepitations at right apex in front and in axilla.

Course: 10*th April.*—Temperature sub-normal all day. Albumen has cleared up. Jaundice of conjunctivae marked. Pneumonic crepitations still heard over front of right chest and in axilla, with slight difference of note on percussion. Patient somewhat knocked out by illness.

13*th April.*—Remains in apathetic state, but is doing well.

16*th April.*—Discharged well.

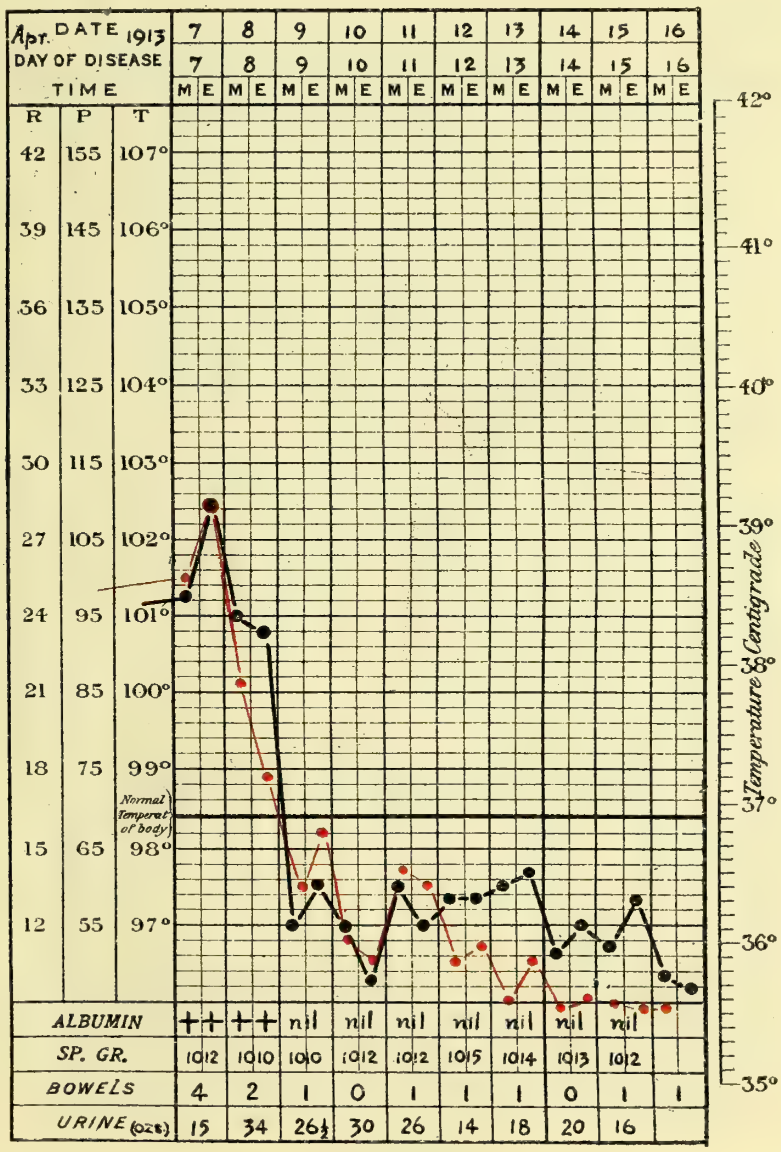


Chart 25

Case 14

Race : Negro.

Age : —

Sex : Male.

Occupation : Labourer.

Date of admission to hospital : 7th April, 1913.

Date of discharge : 16th April, 1913.

History :—

Condition on admission.—Temperature, 102·8° Fahr. Pulse, 110. Pneumonic signs right apex in front. Inclined to delirium. Urine, albuminous.

Course : 13*th April*.—Temperature has been down three days. Physical signs, some friction along upper limit of lung, dullness and crepitations in axilla. Delirium has ceased. Patient asks for food. Has had and still has much albumen in urine. Is decidedly knocked out.

16*th April*.—Discharged well.

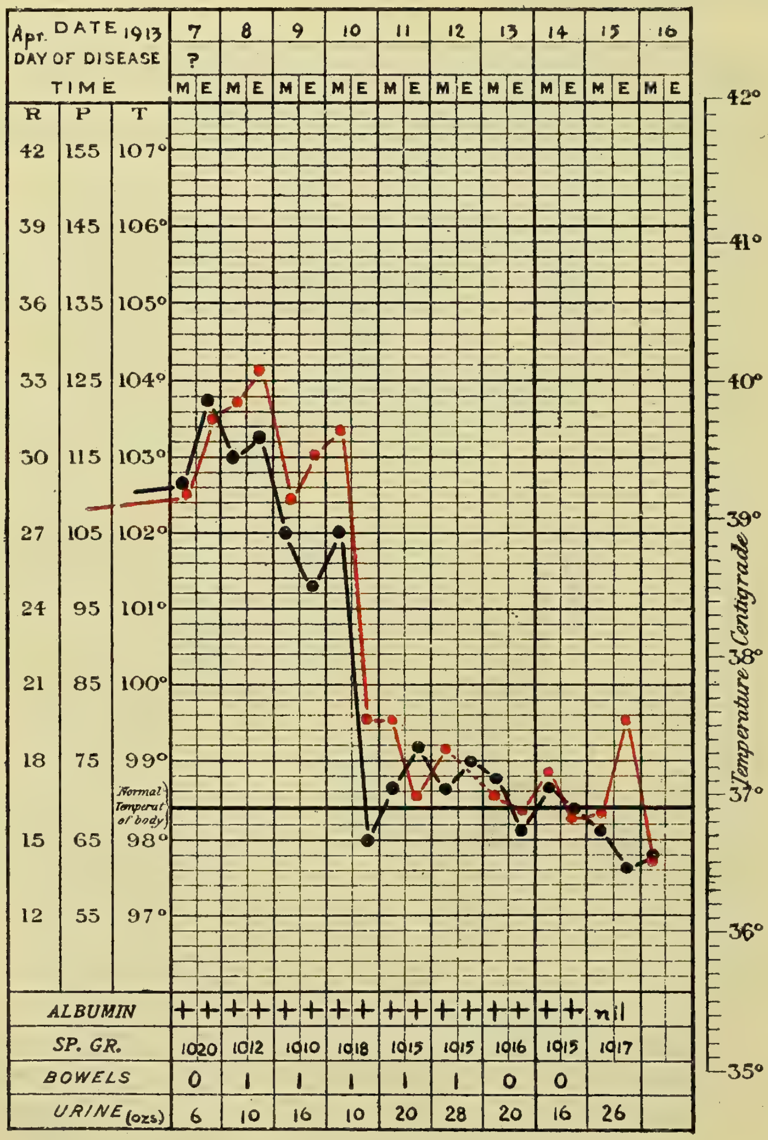


Chart 26

Case 15

Race : Negro.

Age : —

Sex : Male.

Occupation : Labourer.

Date of admission to hospital : 7th April, 1913.

Date of discharge : 25th April, 1913.

History.—Admitted for 'fever' symptoms.

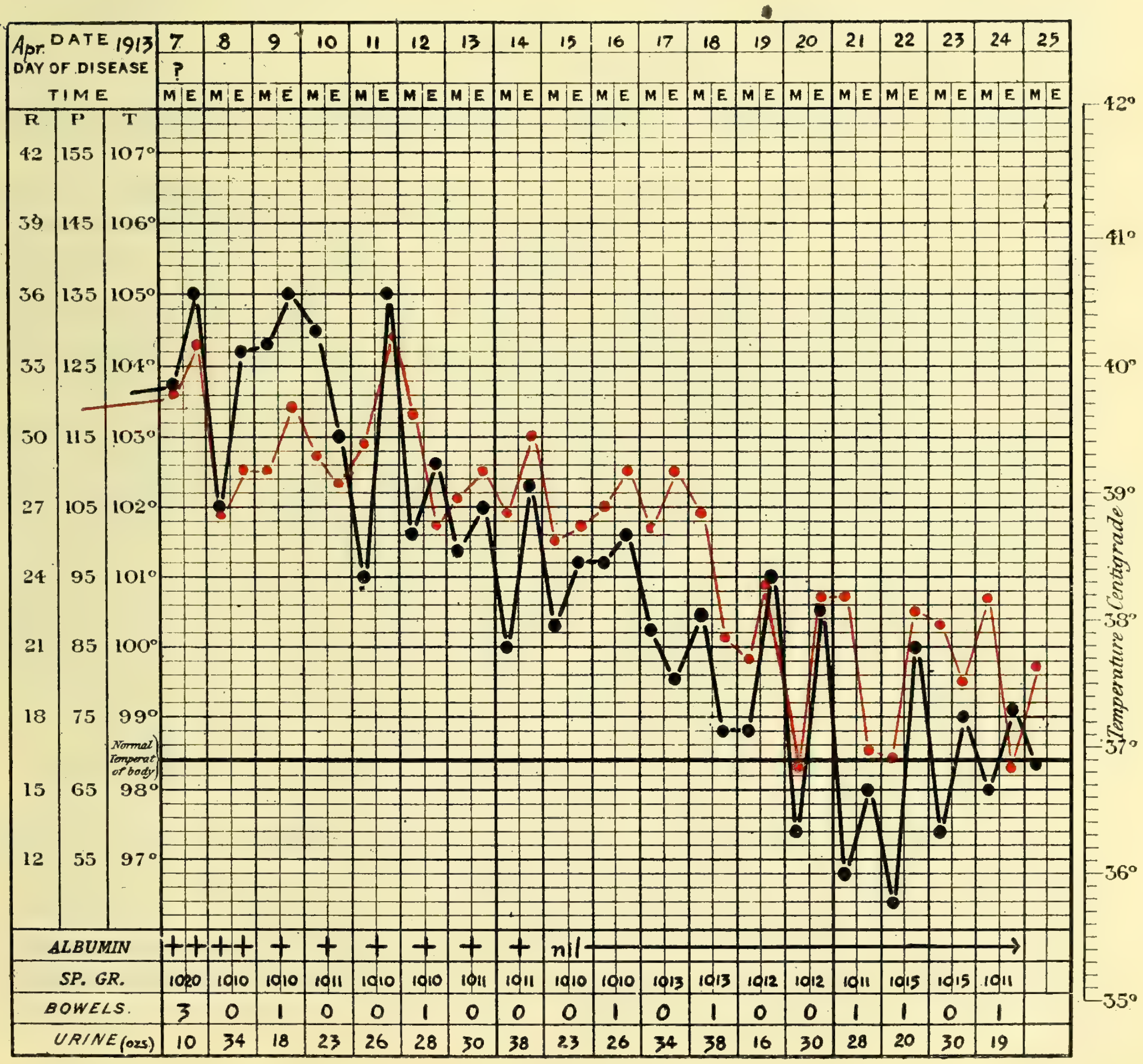
Condition on admission.—Temperature, 103·8° Fahr. Pulse, 122. Bronchitic signs. Urine, albuminous.

Course : 10*th April.*—Temperature remains high. Now signs of pneumonia right base. Much albumen first two days. Yesterday a trace. Patient very sick. Complains of pains in limbs and loins.

13*th April.*—Still runs a fair temperature and is very seedy.

24*th April.*—Discharged well.

No quinine treatment.



Date	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
ALBUMIN	++	++	+	+	+	+	+	+	nil →										
SP. GR.	1020	1010	1010	1011	1010	1010	1011	1011	1010	1010	1013	1013	1012	1012	1011	1015	1015	1011	
BOWELS	3	0	1	0	0	1	0	0	0	1	0	1	0	0	1	1	0	1	
URINE (ozs)	10	34	18	23	26	28	30	38	23	26	34	38	16	30	28	20	30	19	

Chart 27

CASE 16. L. 13†

Race : Negro.
Age : 29.
Sex : Male.
Occupation : Labourer.
Date of admission to hospital : 8th April, 1913.
Date of discharge : 18th April, 1913.

History.—Admitted so deaf as to be useless for any history.

Condition on admission.—Temperature, 103·4° Fahr. Pulse, 124. Tongue, coated with fur. Spleen, enlarged two fingers below ribs. Albuminuria marked. Deafness ceased on 25th April.

Case completed shows a fever, not malarial, characterized by : Albuminuria. Slow pulse. Typical temperature chart. White fur on tongue. Deafness.

CASE 17. L. 5†

Race : Negro.
Age : 16.
Sex : Male.
Occupation : Labourer.
Date of admission to hospital : 23rd April, 1913.
Date of death : 25th April, 1913.

History.—The patient had been living for several weeks on a ship on the slipway at Burutu.

Condition on admission.—Admitted in a sleepy state on 23rd April. Puffy eyes. Slight oedema of legs. Albuminous urine. Temperature ran as by chart. Pulse was not slowed. Eyes were not injected or jaundiced. No vomiting or abdominal symptoms. Liver and spleen enlarged two fingers below ribs. Urine contained albumen but no blood.

Course.—There was some delirium on second day after admission, but usually patient lay quiet, and apathetic. He died on the morning of 26th April.

Post-mortem.—Some adhesions right upper chest. Lungs normal. Heart normal. Liver, spleen and kidney big. Liver, natural colour—slight tendency to a nutmeg appearance. Kidney, cortex appeared fatty. Stomach had quantity of a fluid, about 3 ozs., composed of mucus, water and dark brown stained pieces of mucus. This dark brown colour gave way in small intestine to a more natural colour. The large intestine was full of a dark brown or black substance, the consistency of thick pea-soup. There were no haemorrhages in stomach, heart, bladder or peritoneum. Pieces of liver, spleen, and kidney sent to Lagos for examination.

REPORT FROM MEDICAL RESEARCH INSTITUTE, YABA, ON SPECIMENS FROM CASE 17

. . . . All the specimens (liver, spleen and kidney) were congested, and the two former tissues were heavily charged with black pigment. The kidney showed but slight pathological signs, it was congested, contained a little pigment, and one or two tubules were blocked. I have been unable to detect any evidences of disease that might not be accounted for by a recent malarial infection. From the clinical aspect, had you any reason to suspect any special 'fever'? . . . . . .

J. W. SCOTT MACFIE.

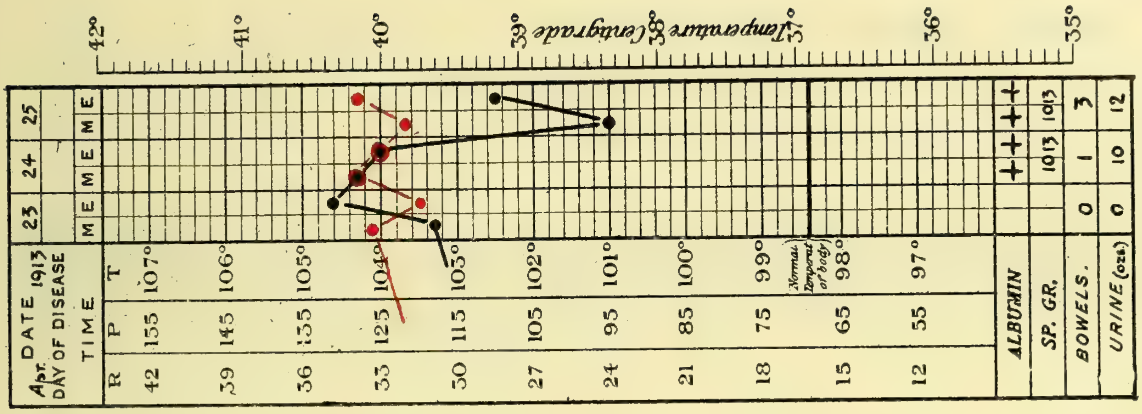


Chart 29. Case 17

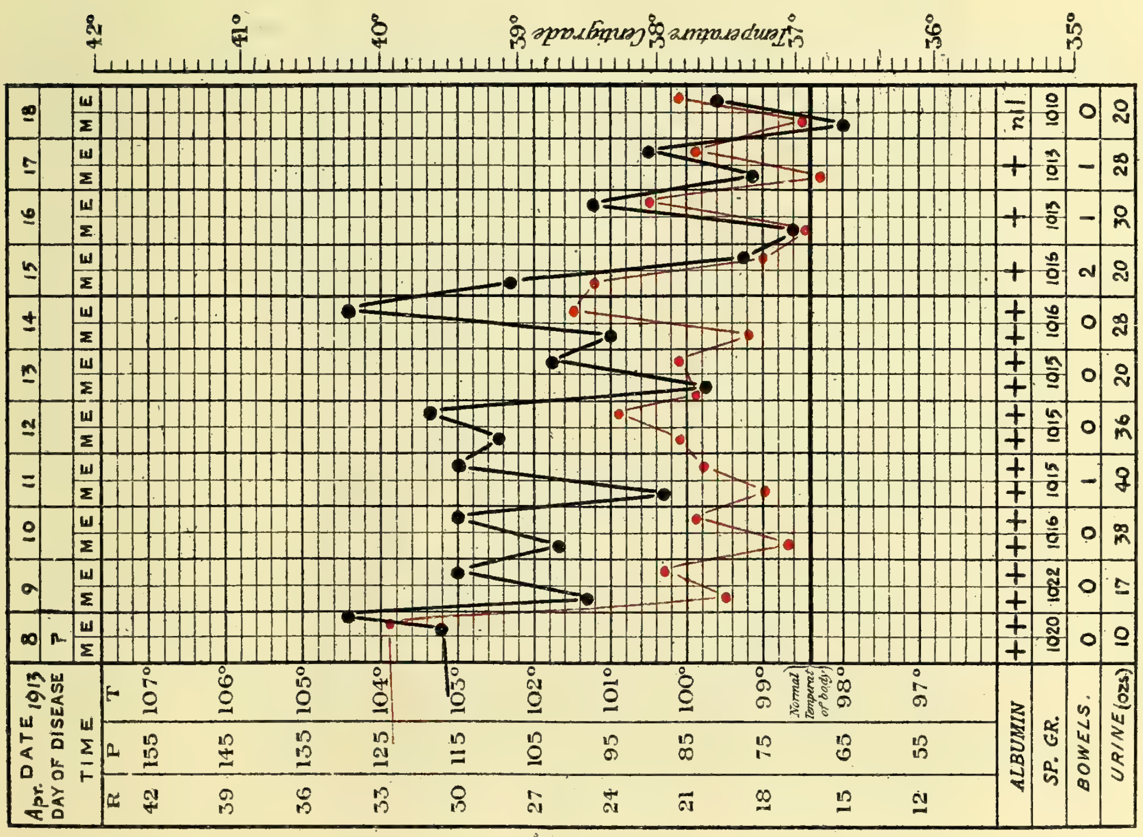


Chart 28. Case 16

CASE 18. *Commission number not obtainable**

Race : Negro.

Age : —

Sex : Male.

Occupation : Labourer.

Date of admission to hospital : 24th April, 1913.

Date of discharge : 2nd May, 1913.

History.—

Condition on admission.—Admitted for fever and albuminuria. Temperature, 103·4° Fahr. Pulse, 108. Eyes, injected. Tongue, furred. Liver, hardened a bit. The fever fell from the start, patient being apparently caught late.

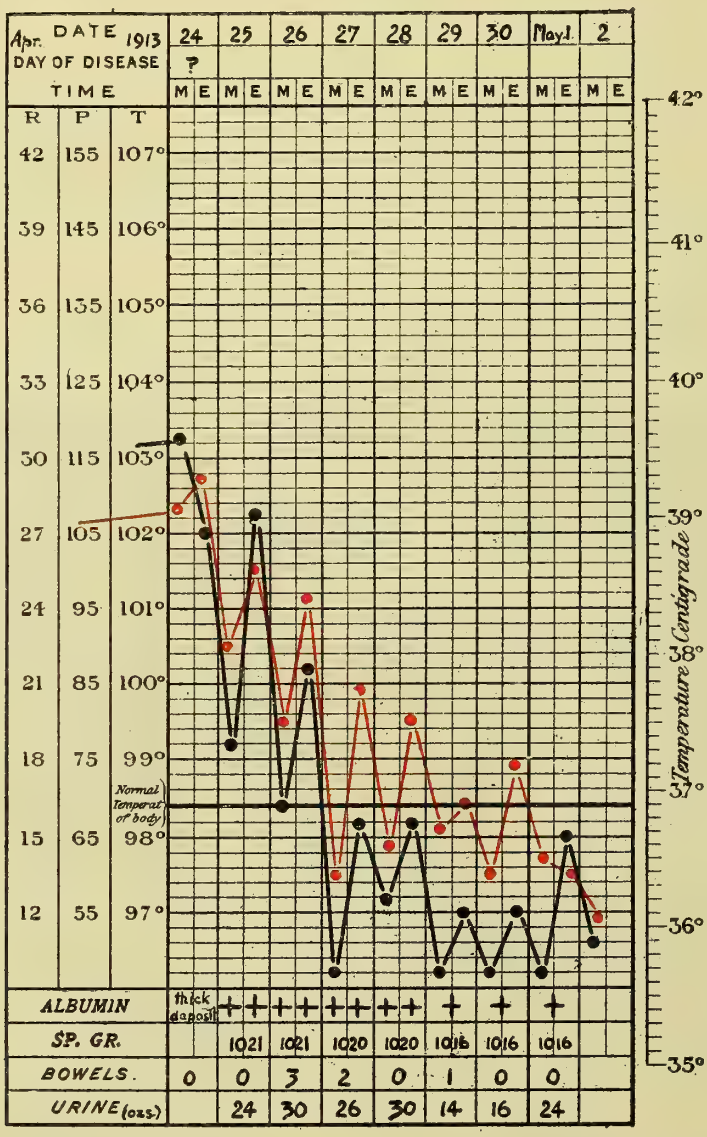


Chart 30.

CASE 19. *Commission number not obtainable**

Race : Negro.

Age : —

Sex : Male.

Occupation : Labourer.

Date of admission to hospital : 8th May, 1913.

Date of discharge : 18th May, 1913.

History.—Of two days' illness.

Condition on admission.—Temperature, 105° Fahr. Pulse, 118. Tongue, some fur. Bowels, not open. Chest, negative. Liver, hard, not enlarged. Spleen, enlarged two fingers. Urine, albuminous on admission. Continued so till 16th May, when patient was convalescent.

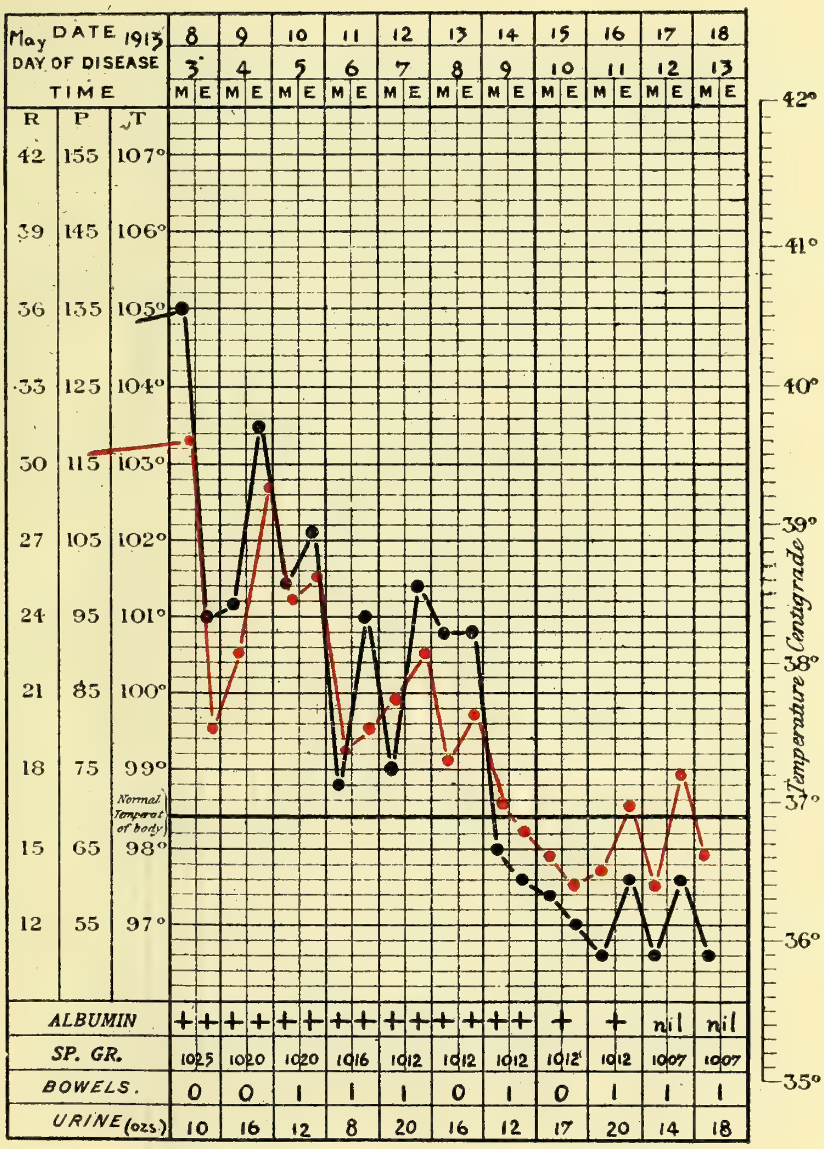


Chart 31.

CASE 20. L. 60†

Race : Negro.

Age : 26.

Sex : Male.

Occupation : Pauper.

Date of admission to hospital : 9th July, 1913.

Date of discharge : 16th July, 1913.

History.—Of two days' illness.

Condition on admission.—Complains of pain over sternum. Temperature, 101·5° Fahr. Pulse, 92. Tongue, red, with white fur. Mouth, dirty. Chest and abdomen, negative. Blood, negative. Urine, not albuminous. Temperature remained about same level for first three days in hospital, and then fell by lysis. Case appeared of same type as others reported from here, but the absence of albumen in the urine is noteworthy. No quinine given.

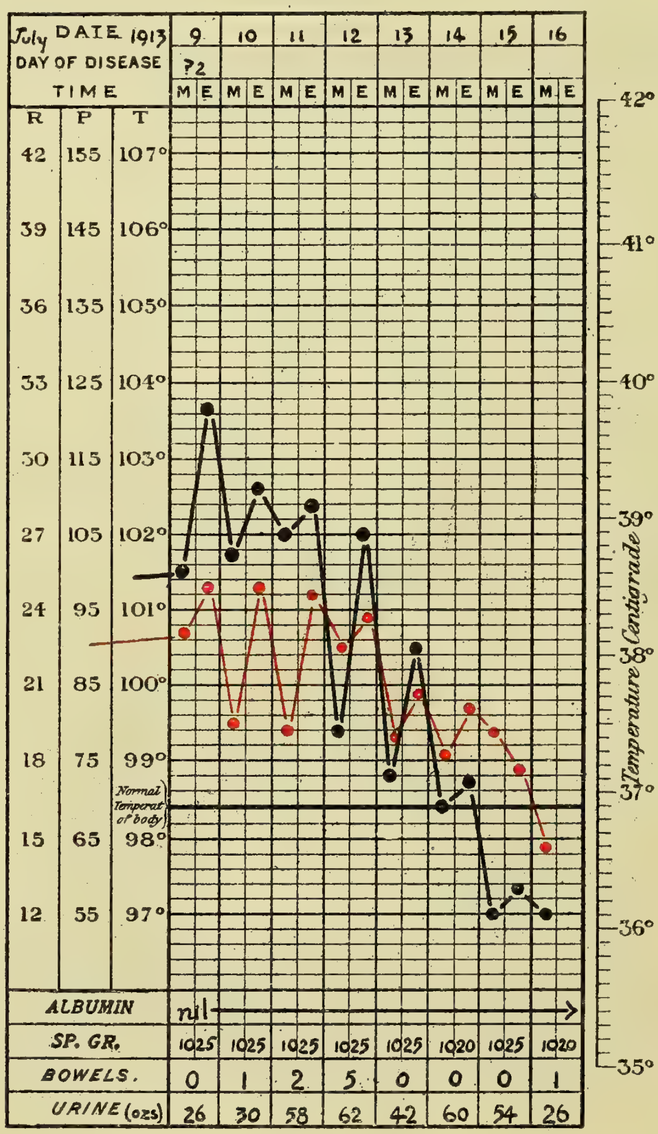


Chart 32.

CASE 21. L. 62†

Race : Negro.

Age : 29.

Sex : Male.

Occupation : Labourer.

Date of admission to hospital : 31st July, 1913.

Date of discharge : 9th August, 1913.

History.—Four days' history of fever.

Condition on admission.—Temperature, 101·5° Fahr. Pulse, 82. Eyes, not red. Tongue, white fur. Chest, negative. Abdomen, spleen three fingers below ribs. Urine, albuminous, reducing with convalescence. Blood, *Paraplasma* found.

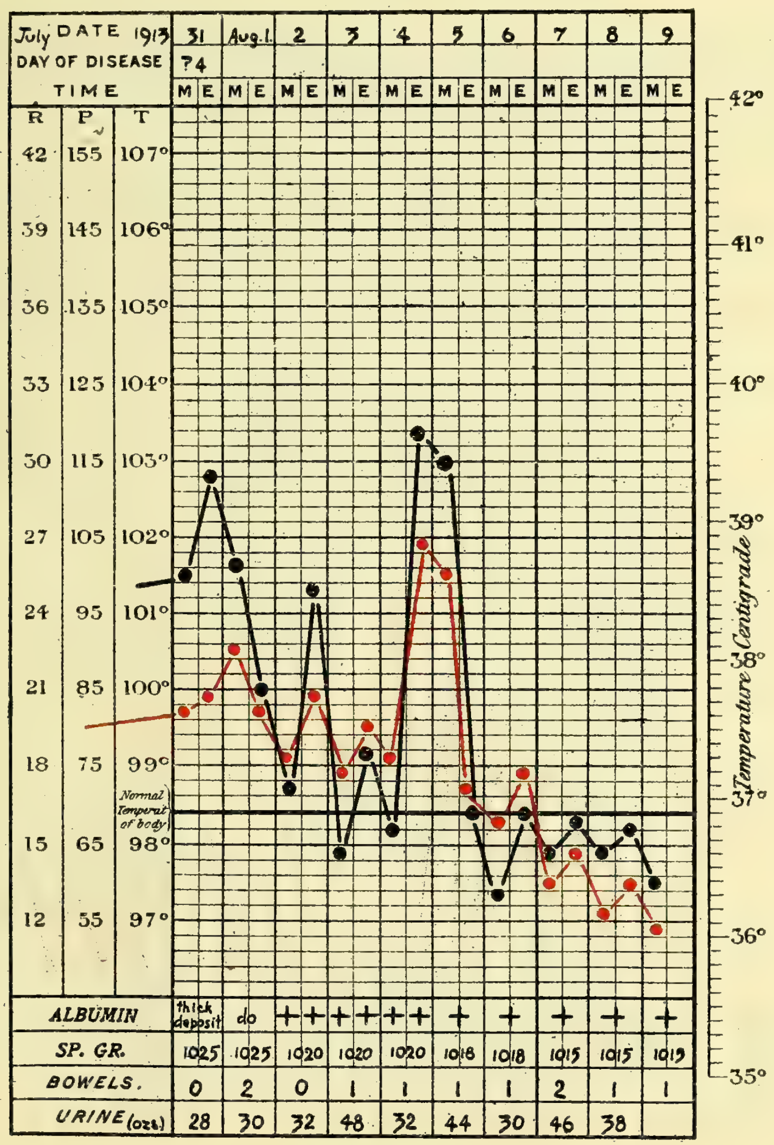


Chart 33.

CASE 22. *Commission number not obtainable*

Race: Negro.

Age: —

Sex: Male.

Occupation: Fireman.

Date of admission to hospital: 5th May, 1913.

Date of discharge: 18th May, 1913.

History.—Two days' fever.

Condition on admission.—Temperature, 101·5° Fahr. Pulse, 72. Eyes, not injected. Physical examination negative except that liver was palpable. No vomiting or jaundice. Temperature fell on 7th May, and stayed down. Urine, albuminous on admission; continued so till 14th May.

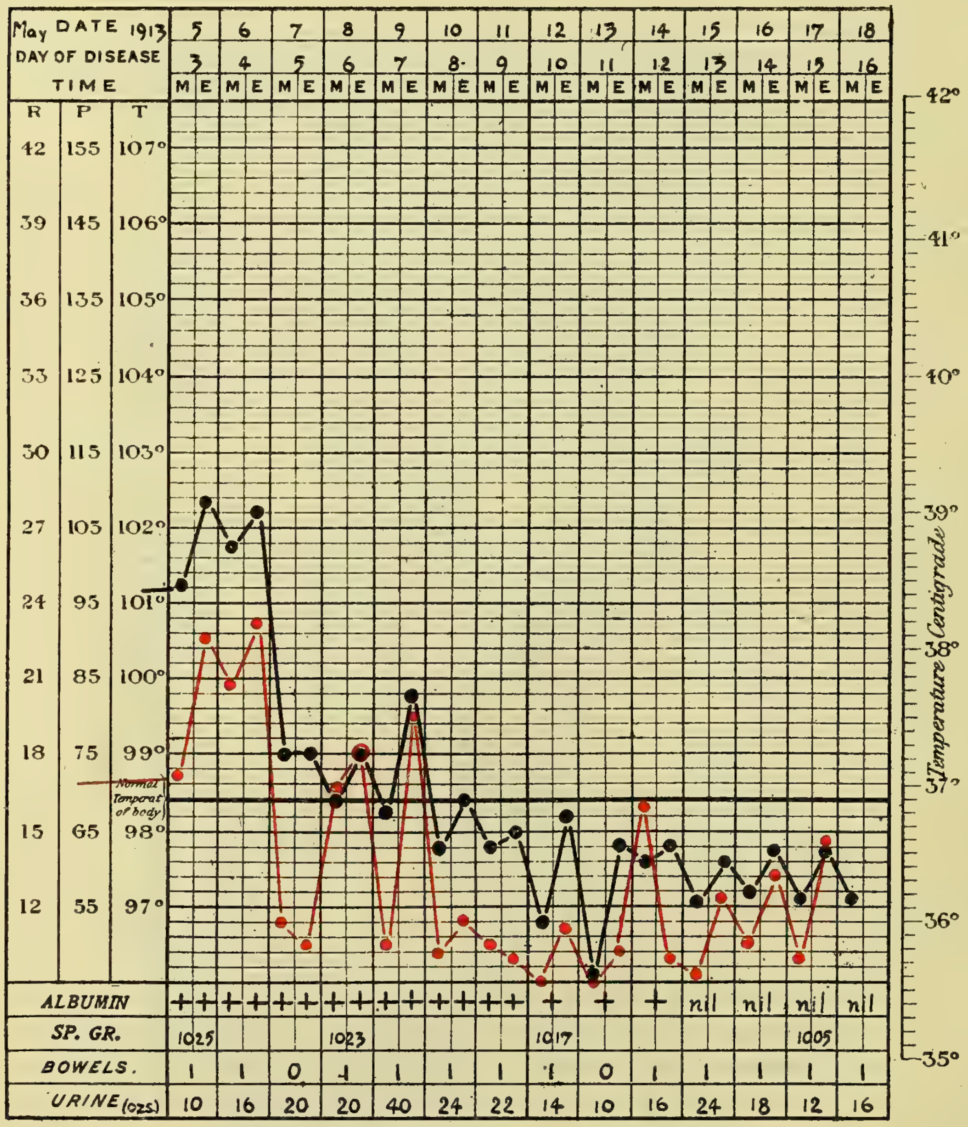


Chart 34

CASE 23. L. 61†

Race: Negro.

Age: 27.

Sex: Male.

Occupation: Labourer.

Date of admission to hospital: 24th July, 1913.

Date of discharge: 30th July, 1913.

History.—Of one day's duration. Complained of pain in chest and head.

Condition on admission.—Temperature, 100·2° Fahr. Pulse, 78. Eyes, not injected. Tongue, clean and moist. Chest, some slight bronchitic signs; no tenderness over sternum. Abdomen, negative. Urine, thick albumen, getting less with convalescence. A mild fever.

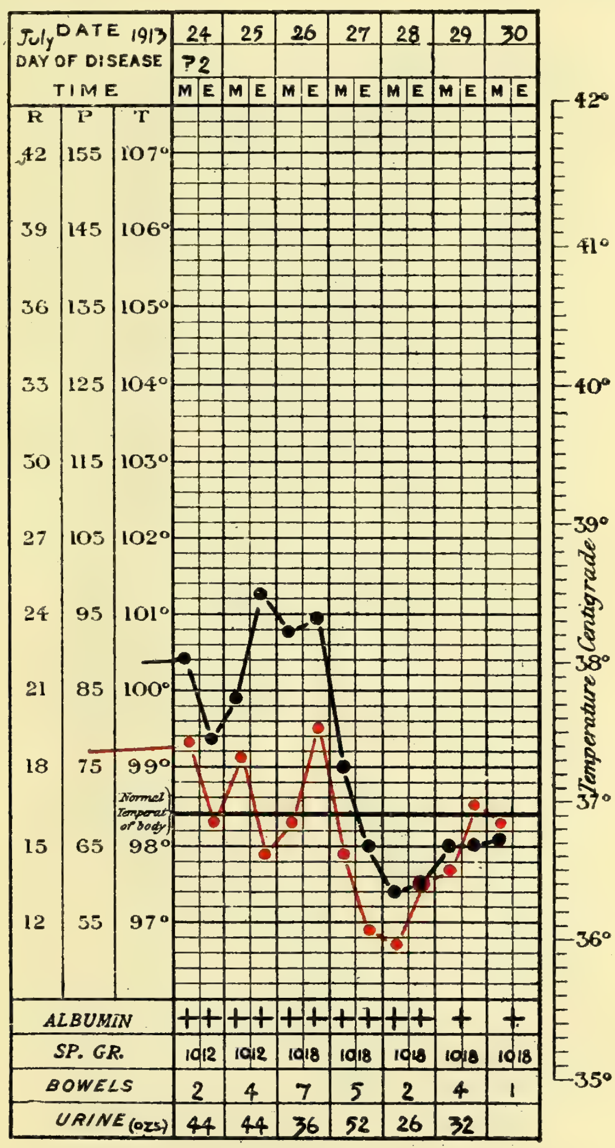


Chart 35

CASE 24. L. 74†

Race : Negro.

Age : 24.

Sex : Male.

Occupation : Labourer.

Date of admission to hospital : 29th August, 1913.

Date of discharge : 2nd September, 1913.

History.—Indefinite.

Condition on admission.—Temperature, 100·8° Fahr. Pulse, 86. Eyes, somewhat injected. Tongue, clean. Chest and abdomen, negative; no nausea, vomiting, or epigastric tenderness. Urine, albuminuria, which cleared up in three days; quantity, normal; no blood, casts, or bile pigment. Skin, dry. Haemorrhages absent. Stools, normal. Nervous system, nil.

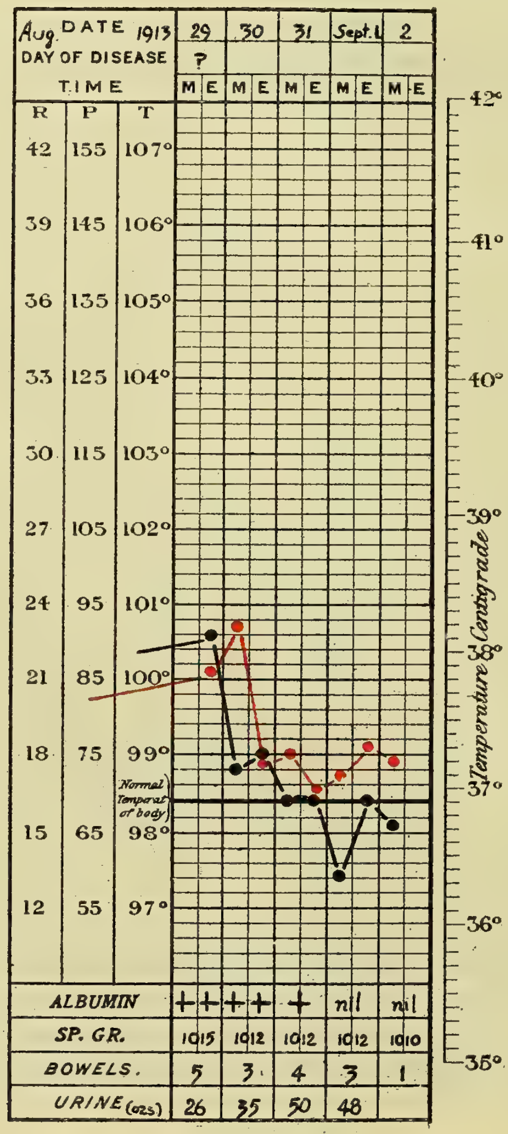


Chart 36

CASE 25. L. 80†

Race: Negro.

Age: 12.

Sex: Male.

Occupation: Pauper.

Date of admission to hospital: 3rd September, 1913.

Date of discharge: 8th September, 1913.

History.—Stated that he had been seedy for two weeks since arriving at Forcados. His master said he had been constipated.

Condition on admission.—Temperature, 101·4° Fahr. Pulse, 116; Faget's sign absent. Eyes, he had a heavy-eyed appearance. Tongue, red, with white fur. Chest and abdomen, negative; no nausea, vomiting, or epigastric tenderness. Urine, a slight cloud of albumen in first specimen only; quantity, increased; no blood, casts, or bile pigment. Stools, normal; constipated. Haemorrhages, absent. Skin, normal.

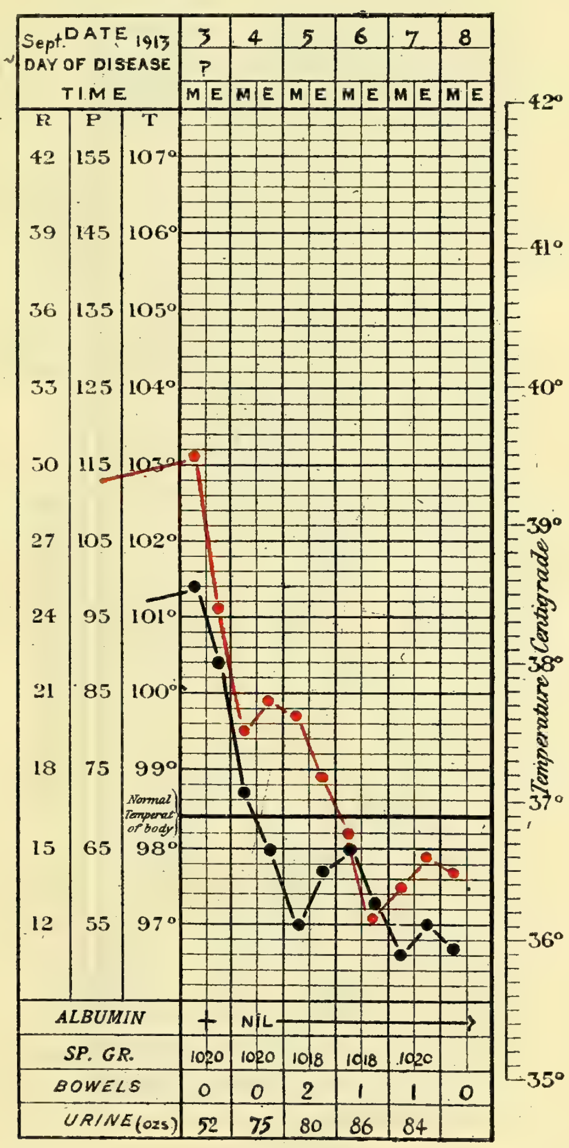


Chart 37

CASE 26. L. 75†

Race: Negro.

Age: 17.

Sex: Male.

Occupation: Labourer.

Date of admission to hospital: 4th September, 1913.

Date of discharge: 8th September, 1913.

History.—History of one day's headache.

Condition on admission.—Temperature, 100° Fahr. Pulse, 94. Eyes, not injected. Tongue, red and furred. Chest and abdomen, negative except spleen enlarged hand's-breadth below ribs; no nausea, vomiting, or epigastric tenderness. Urine, marked albuminuria first three days; quantity somewhat increased; no blood, casts, or bile pigment. Stools, normal; constipated. Skin, dry. Haemorrhages, absent. A very mild case.

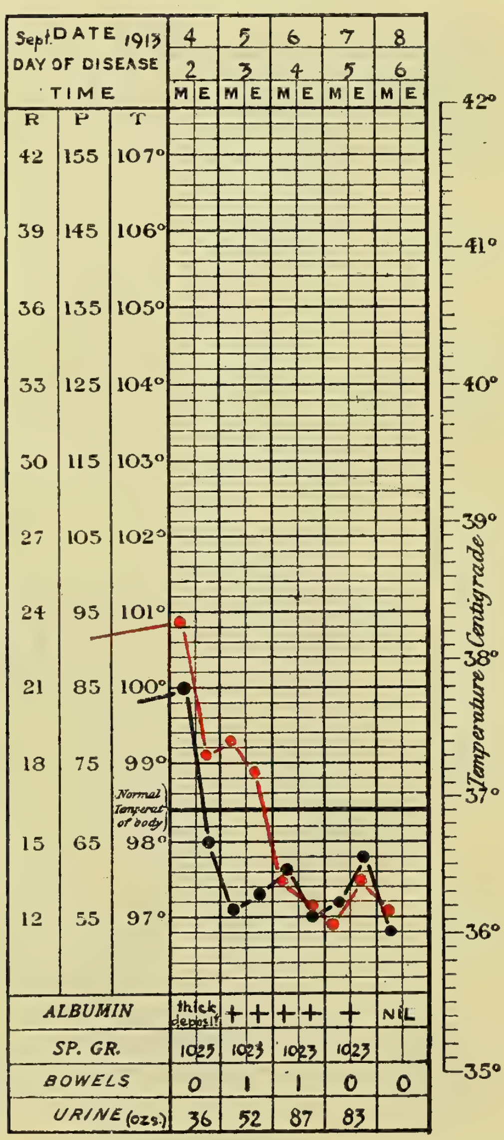


Chart 38

CASE 27. L. 76†

Race : Negro.

Age : 13.

Sex : Male.

Occupation : Schoolboy.

Date of admission to hospital : 5th September, 1913.

Date of discharge : 9th September, 1913.

History.—History of pain in head day before ; also pain in belly.

Condition on admission.—Temperature, 103·5° Fahr. Pulse, 126. Eyes, not red. Tongue, slight white fur. Chest, negative. Abdomen, said to be painful all over, but not tender to pressure ; no nausea or vomiting ; spleen enlarged three fingers'-breadth and liver enlarged two fingers'-breadth below ribs. Urine, albumen present ; quantity increased ; no blood, casts, or bile pigment. Skin, nil. Haemorrhages, absent. Stools, normal. Jaundice, absent. A mild case.

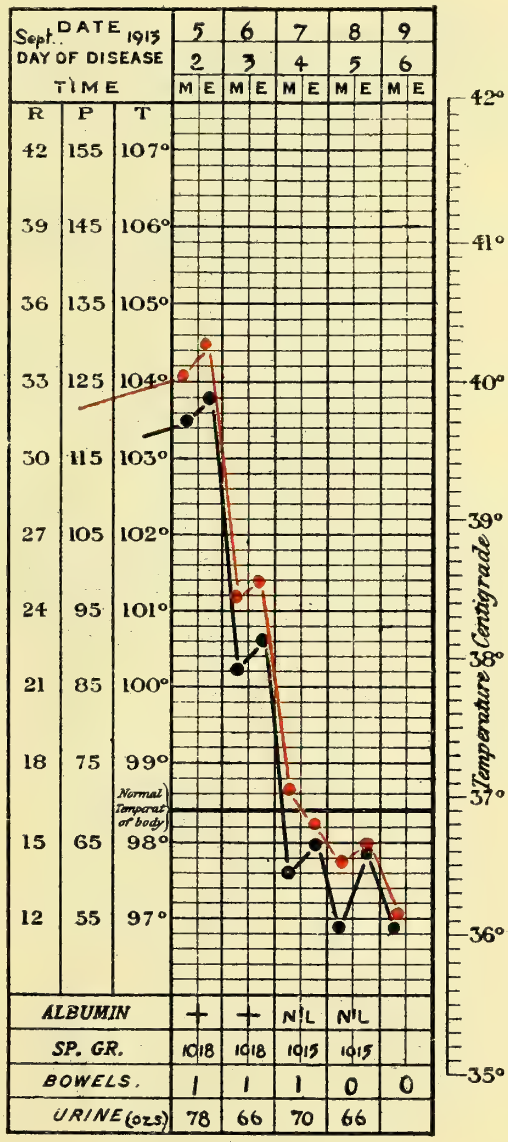


Chart 39

CASE 28. L. 77†

Race: Negro.

Age: 22.

Sex: Male.

Occupation: Clerk.

Date of admission to hospital: 8th September, 1913.

Date of discharge: 11th September, 1913.

History.—Stated that he had fever two days before admission.

Condition on admission.—Temperature, 100° Fahr. Pulse, 86. Eyes, slightly injected. Tongue, clean; red. Chest and abdomen, negative; no nausea, vomiting, or epigastric tenderness. Urine, slight cloud of albumen on day of admission; absent next day; quantity, normal; no blood, casts, or bile pigment. Stools, normal. Skin, nil. Haemorrhages, absent. Jaundice, absent.

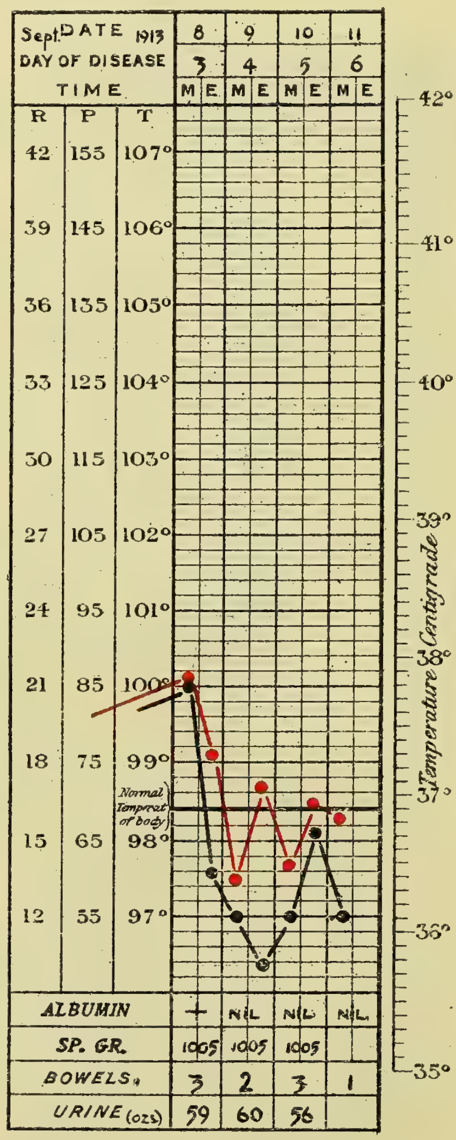


Chart 40

CASE 29. L. 78†

Race: Negro.

Age: 16.

Sex: Male.

Occupation: Pauper.

Date of admission to hospital: 9th September, 1913.

Date of discharge: 17th September, 1913.

History.—Stated to be second day of fever.

Condition on admission.—Temperature, 99·8° Fahr. Pulse, 94. Eyes, not injected. Tongue, clean; red. Chest, base of right lung some crepitations, with slight cough; no dullness. Abdomen, spleen just below ribs; otherwise no signs; no nausea, vomiting, or epigastric tenderness. Urine, albuminuria, which diminished with the fever; quantity, normal; no blood, casts, or bile pigment. Jaundice, absent. Skin, normal. Stools, normal. A very mild case.

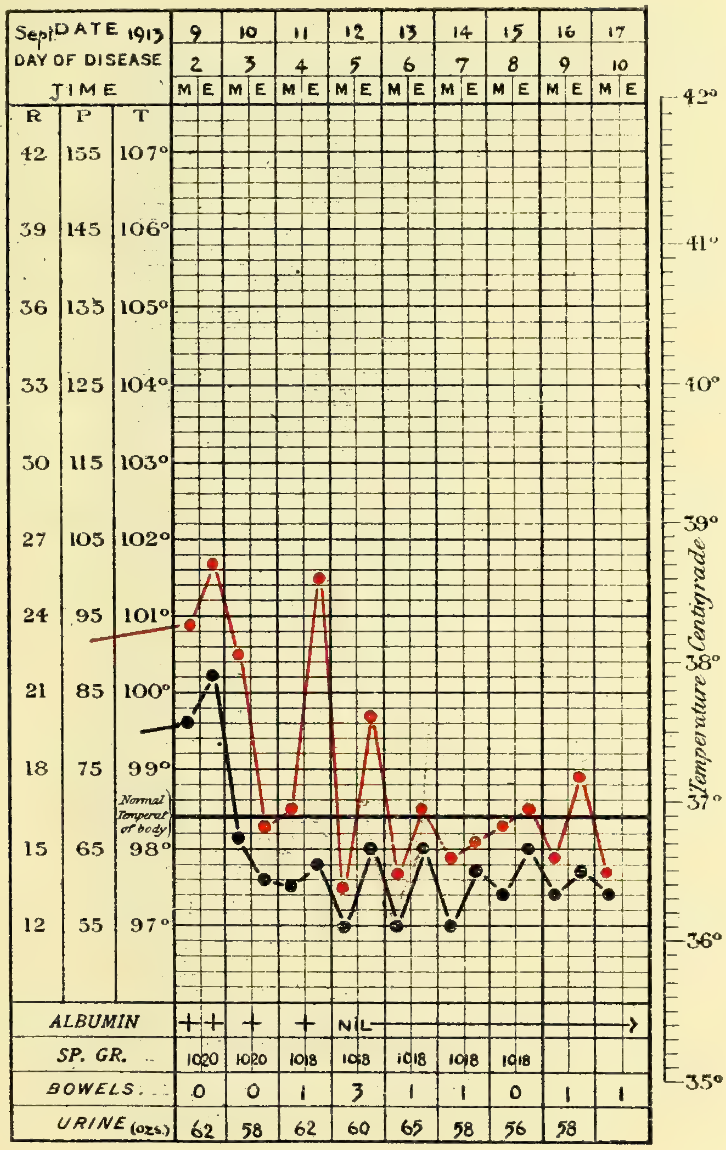


Chart 41

CASE 30. L. 79†

Race: Negro.

Age: 26.

Sex: Male.

Occupation: Servant.

Date of admission to hospital: 12th September, 1913.

Date of discharge: 17th September, 1913.

History.—Admitted, according to his account, on the sixth day of fever.

Condition on admission.—Temperature, 101·5° Fahr. Pulse, 86. Eyes, not injected. Tongue, red, white fur. Chest and abdomen, negative; no nausea, vomiting, or epigastric tenderness. Urine, trace of albumen found on the first day in hospital, cleared up rapidly and convalescence began; quantity, normal except first day, when small; no blood, casts, or bile pigment. Stools, normal. Jaundice, absent. Haemorrhages, absent. Skin, normal. A very mild case.

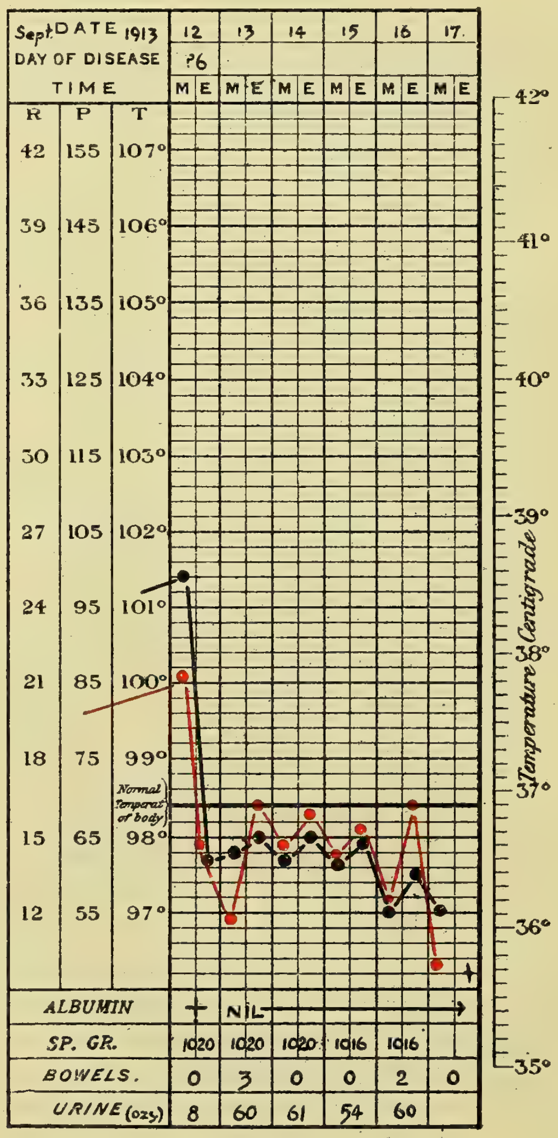


Chart 42

CASE 31. L. 97†

Race : Negro.

Age : 24.

Sex : Male.

Occupation : Labourer.

Date of admission to hospital : 22nd September, 1913.

Date of discharge : 3rd October, 1913.

History.—History of three days' illness before admission, headache and pains in epigastrium ; some joint pains, said to have finished on admission.

Condition on admission.—Temperature, 102·4° Fahr. Pulse, 126. Eyes, not injected. Tongue, red ; slightly tremulous. Chest and abdomen, negative ; slight cough. Urine, cloud of albumen.

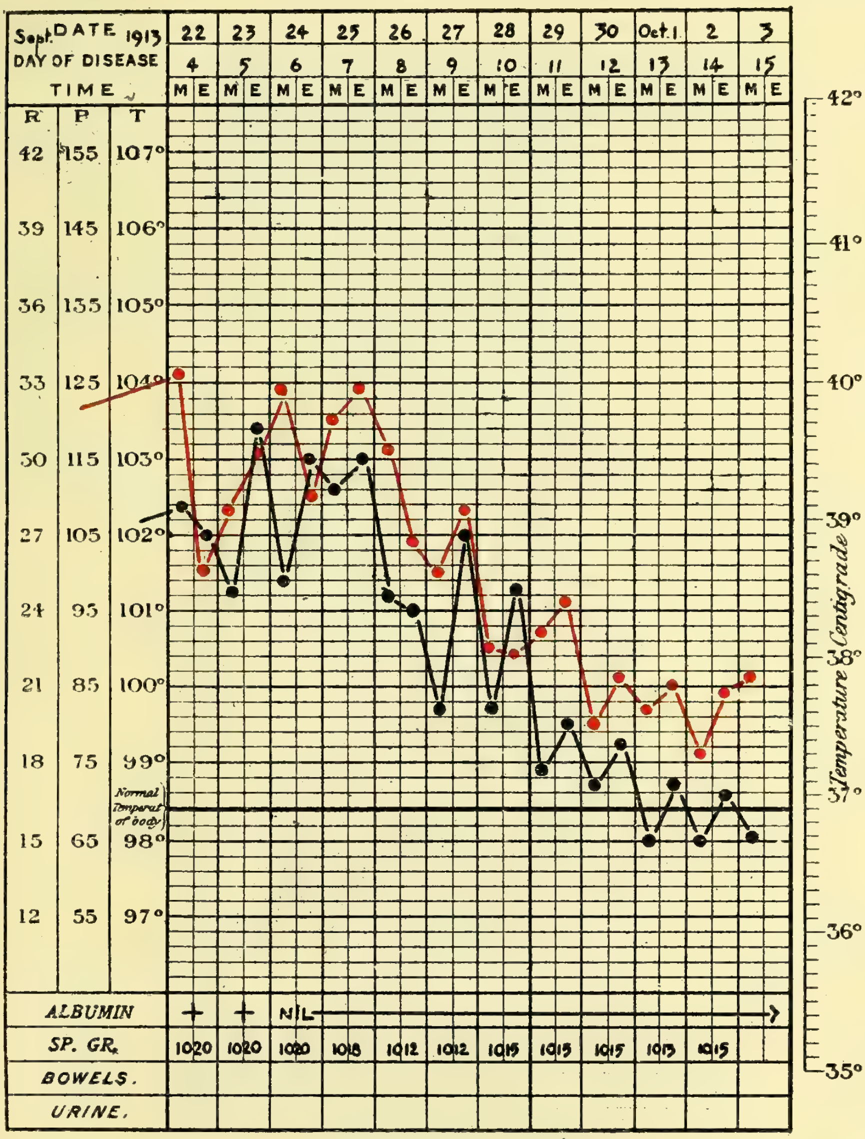


Chart 43

CASE 32. L. 96†

Race: Negro.

Age: 22.

Sex: Male.

Occupation: Labourer.

Date of admission to hospital: 23rd September, 1913.

Date of discharge: 28th September, 1913.

History.—History of being taken ill day before admission, with headache Found to have albuminuria and admitted.

Condition on admission.—Temperature, 99·8° Fahr. Pulse, 120. Eyes, slightly injected. Tongue, red; white fur on dorsum. Chest and abdomen, negative. The patient had lived in the Asaba 'boys' house, Messrs. Elder Dempster's 'beach,' for four months.

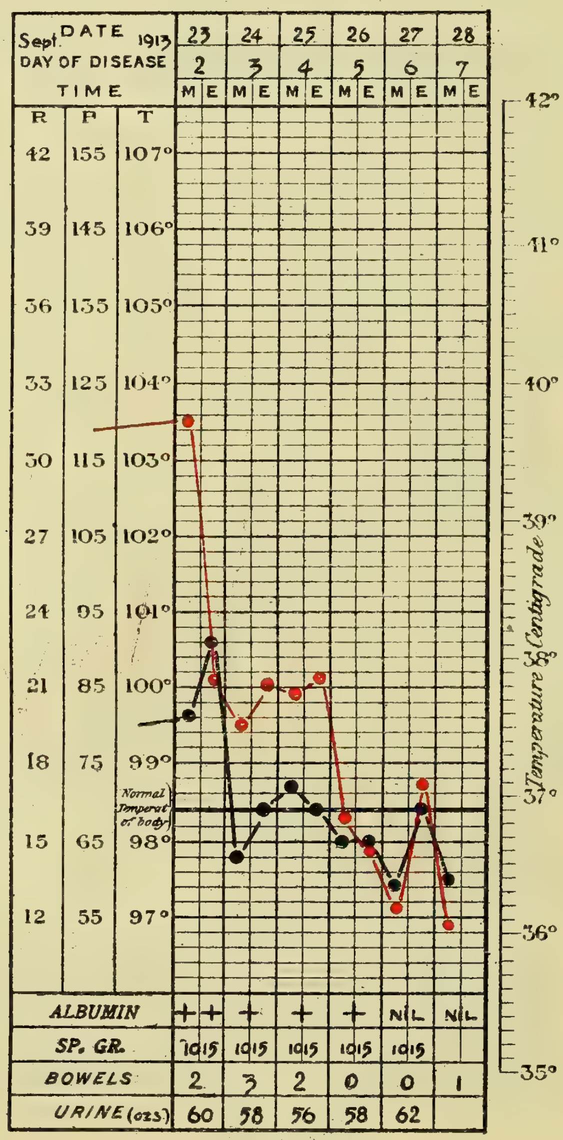


Chart 44

Case 33. L. 95†

Race : Negro.

Age : 23.

Sex : Male.

Occupation : Engineer.

Date of admission to hospital : 25th September, 1913.

Date of discharge : 28th September, 1913.

History.—On admission complained of a light fever lasting to this, the fourth day.

Condition on admission.—Temperature, 98·4° Fahr. Pulse, 72. Eyes, not injected. Tongue, moist and good ; slight white fur. Chest, negative. Abdomen negative, except that liver just palpable on deep expiration. No headache or pain. Urine, found free from albumen day before admission ; a cloud on day of admission.

The patient had lived in the Mechanics' Lines at Forcados for twenty-two months.

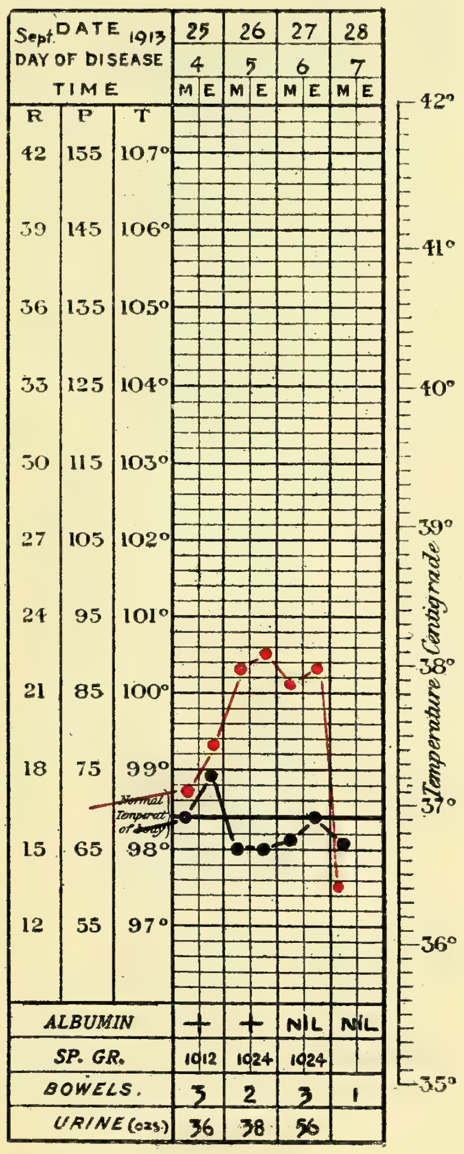


Chart 45

CASE 34. L. 99†

Race : Negro.

Age : 24.

Sex : Male.

Occupation : Clerk.

Date of admission to hospital : 26th September, 1913.

Date of discharge : 28th September, 1913.

History.—Stated that he had headache yesterday. No fever.

Condition on admission.—Professed to be quite well. Temperature, 98·8° Fahr. Pulse, 86. Eyes, not injected. Tongue, moist; very slight fur. Chest and abdomen, negative. Urine, a slight cloud of albumen.

The patient lived in the most westerly of the 'Pigeon beach' houses.

The *Paraplasma flavigenum* was found in the blood at the Medical Research Institute, Yaba.

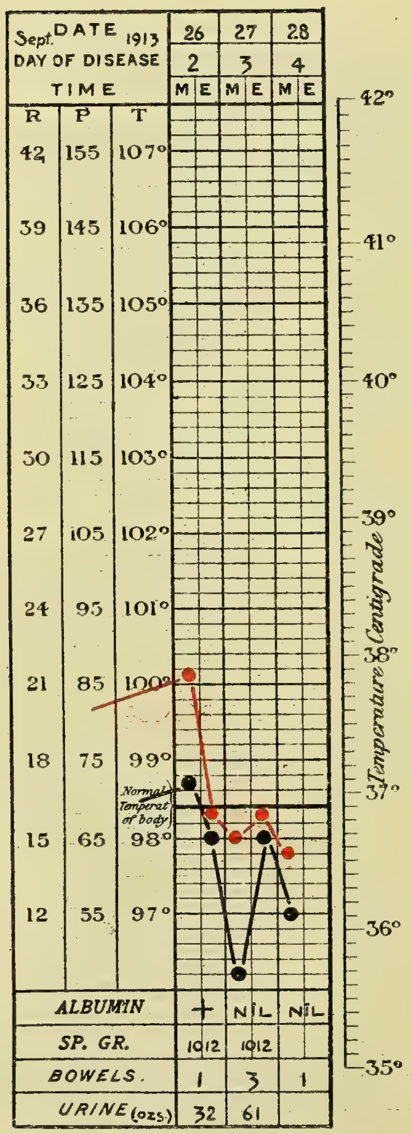


Chart 46

CASE 35. L. 94†

Race: Negro.

Age: —

Sex: Male.

Occupation: Labourer (fireman on station launch 'Aro.').

Date of admission to hospital: 26th September, 1913.

Date of discharge: 3rd October, 1913.

History.—Began to be ill two days before admission—constipation, headache, eyeache.

Condition on admission.—Temperature, 100·2° Fahr. Pulse, 112. Eyes, ? slight injection. Tongue, indented; not bright red; thick white fur; breath very foul. Chest, some crepitations right base; no cough acknowledged or heard. Abdomen, negative. Urine, albuminous.

The patient lives on 'Chikoko Beach,' Forcados.

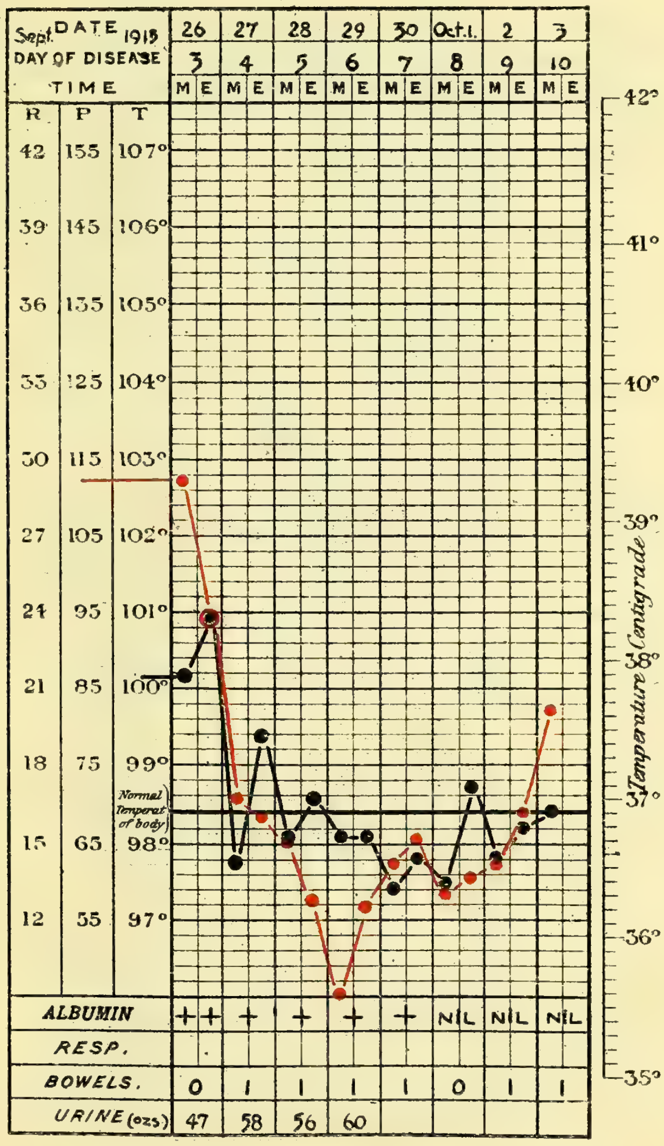


Chart 47

Case 36. L. 98†

Race: Negro.

Age: 24.

Sex: Female.

Occupation: Pauper.

Date of admission to hospital: 26th September, 1913.

Date of discharge: 3rd October, 1913.

History.—Ill for over a week—headache; later, pains in joints.

Condition on admission.—Temperature, 100° Fahr. Pulse, 110. Eyes, not injected. Tongue, very light fur. Chest, negative. Abdomen, liver palpable on expiration; spleen not palpable. Urine, albuminous.

The patient had lived for some time in the Mechanics' Lines, Forcados.

Malaria parasites were found in the blood at the Medical Research Institute, Yaba.

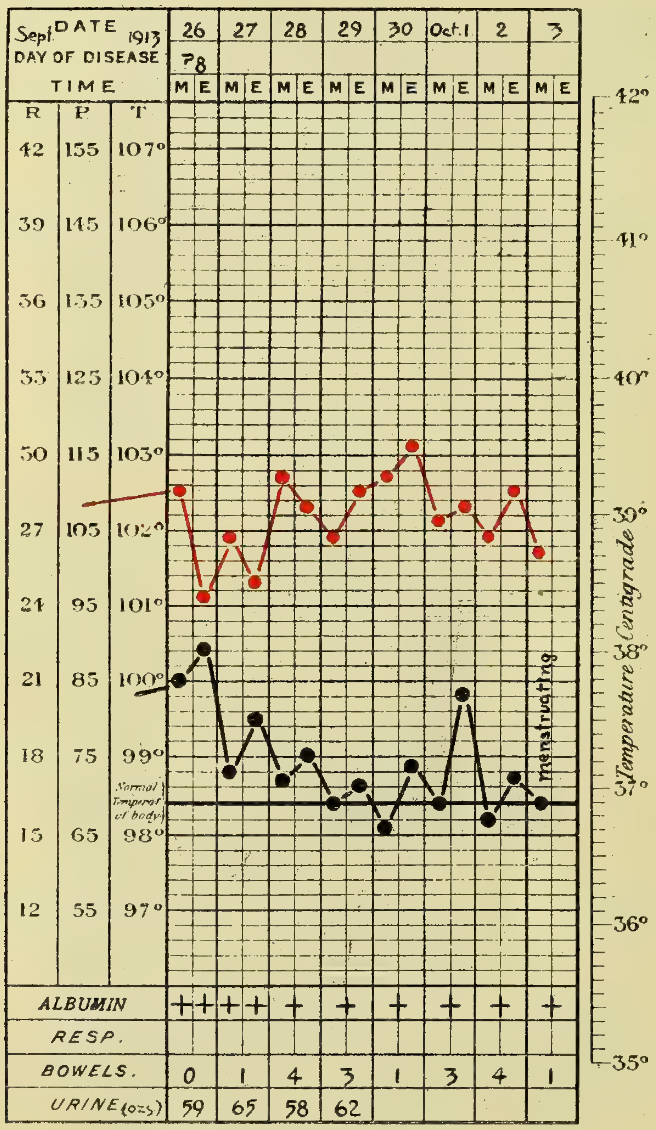


Chart 48

CASE 37. L. 93†

Race: Negro.

Age: —

Sex: Male.

Occupation: Labourer.

Date of admission to hospital: 23rd September, 1913.

Date of discharge: 26th September, 1913.

History.—Began to be ill day before admission. 'Cold catch him' and 'belly full up,' causing constipation.

Condition on admission.—Temperature, 103·4° Fahr. Pulse, 100. Eyes, not injected. Tongue, slightly furred. Chest, negative. Abdomen, liver felt on deep expiration. Urine, not albuminous.

Patient lives on 'stern-wheeler' 'Egbon,' alongside wharf.

'Seidelin bodies' found by Dr. Seidelin.

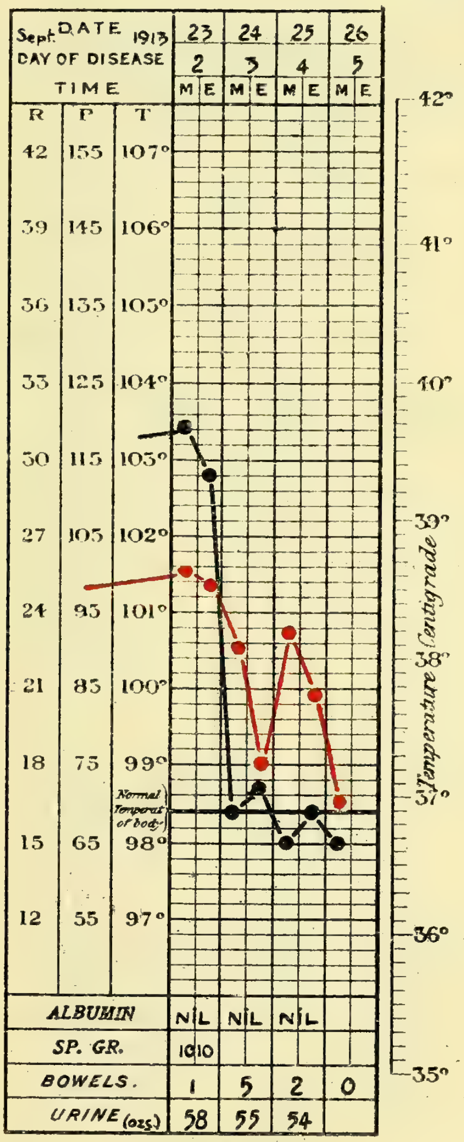


Chart 94

CASE 38. L. 92†

Race: Negro.

Age: —

Sex: Male.

Occupation: —

Date of admission to hospital: 3rd October, 1913.

Date of discharge: 7th October, 1913.

History.—The illness began day before admission, with pains in head and back over top of sacrum.

Condition on admission.—Temperature, 102·2° Fahr. Pulse, 96. Eyes, injected. Tongue, white fur. Breath, foul. No constipation. No epigastric tenderness. Chest, slight systolic murmur at apex, not conducted. *No* albuminuria.

The patient was treated with quinine.

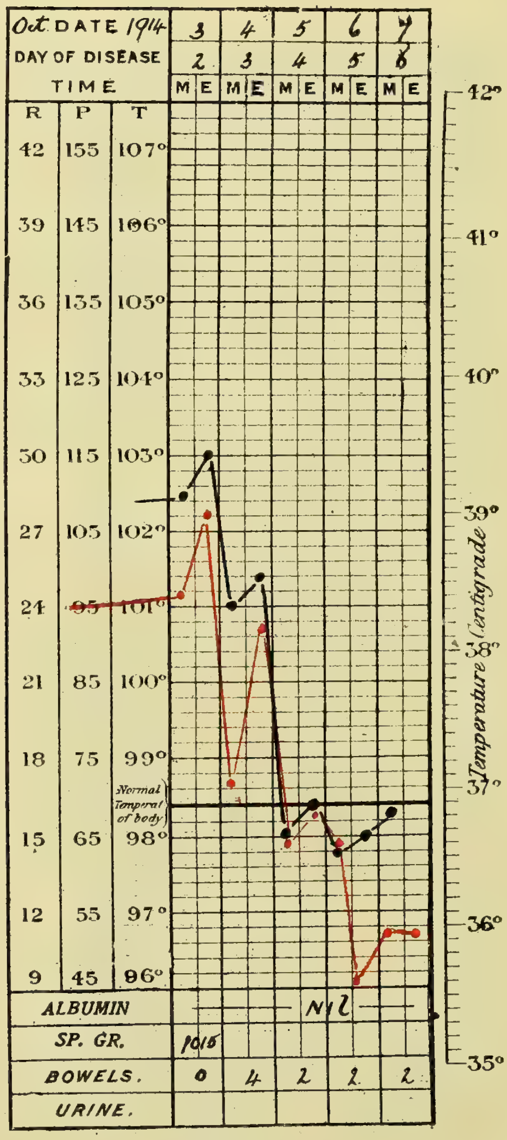


Chart 50

Case 39

Race : Negro.

Age : 28.

Sex : Male.

Occupation : Clerk.

Date of admission to hospital : 8th October, 1913.

Date of discharge : 9th October, 1913.

8th October.—Patient felt tired last night after sea-trip on s.s. 'Niger' from Lagos. Is always very seasick. Admitted this morning with temperature at 99·4° and very slight albuminuria. Chest, negative. Abdomen, liver just palpable on very deep expiration, otherwise absolutely negative. Eyes, not the least injection. Tongue, yellow fur, said to be habitual, on dorsum.

9th October.—Albumen not found by self yesterday afternoon in carefully filtered specimen, nor this morning. Albuminuria taken to be 'cyclical' and man discharged.

(He left Lagos at 3 p.m. on 6th, landed at Forcados at 5 p.m. on 7th, feeling well ; began to feel seedy after reaching his quarters.)

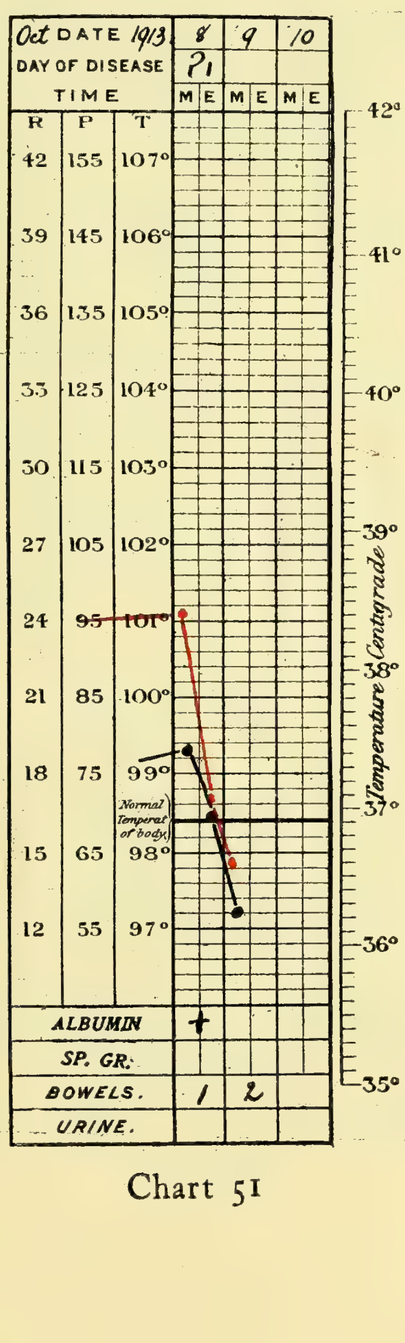


Chart 51

CASE 40. *Commission number not obtainable*

Race: Negro.

Age: 26.

Sex: Male.

Occupation: Prisoner.

Date of admission to hospital: 9th October, 1913.

Date of discharge: 15th October, 1913.

History.—Found to be 'shaking' on morning of 9th. Has been attending out-patients' for boil on back.

Condition on admission.—Temperature, 103° Fahr. Pulse, 120. Eyes, not injected. Tongue, clean, red, moist. Chest and abdomen, negative. Urine, cloud of albumen.

Treatment.—Quinine 10 grains t.d.s. from the commencement.

Paraplasma flavigenum found at Medical Research Institute, Yaba.

This patient had been in Forcados Prison since 27th January, 1913.

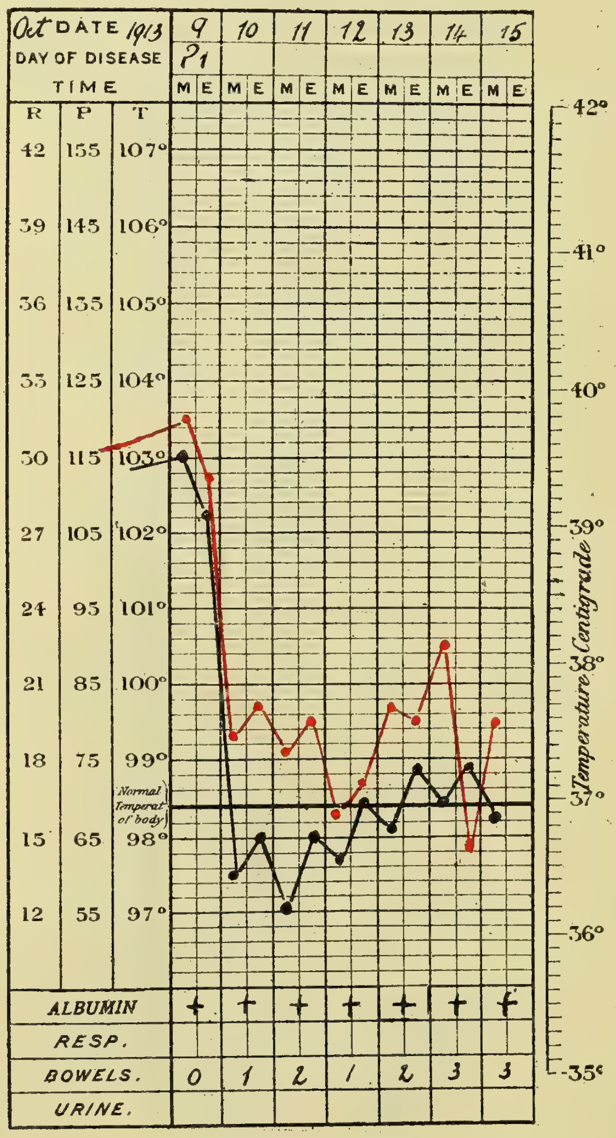


Chart 52

CASE 41. *Commission number not obtainable**

Race: Negro.

Age: 21.

Sex: Male.

Occupation: Labourer.

Date of admission to hospital: 10th October, 1913.

Date of discharge: 18th October, 1913.

History.—Said he began to be ill on morning of 9th; headache and 'fever.'

Condition on admission.—Temperature, 100·3° Fahr. Pulse, 116. Eyes, not injected. Tongue, pale; indented. Chest and abdomen, negative. Urine, albuminous.

The patient ran away from hospital, but was re-caught on the 14th.

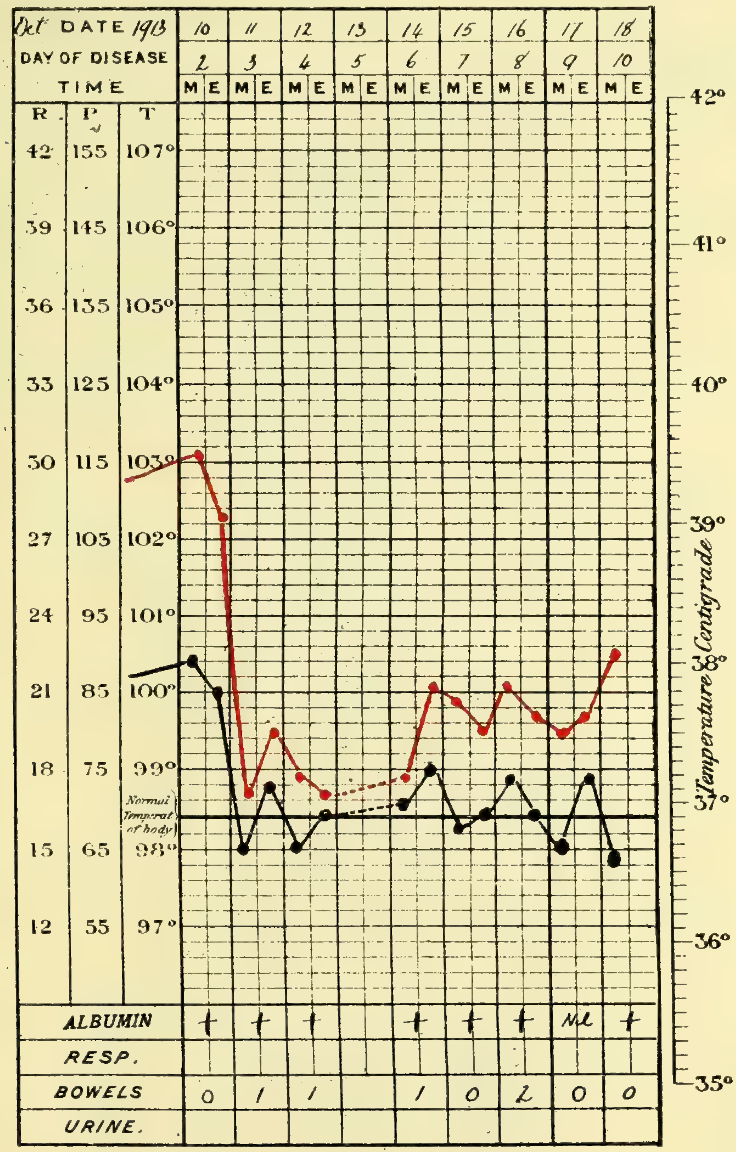


Chart 53

CASE 42. *Commission number not obtainable**

Race: Negro.

Age: 24.

Sex: Male.

Occupation: Prisoner.

Date of admission to hospital: 10th October, 1913.

Date of discharge: 11th October, 1913.

History.—Found shivering in prison on morning of 9th.

Condition on admission.—Temperature, 98° Fahr. Pulse, 78. Eyes, slightly injected. Tongue, moist; clean. Chest and abdomen, negative. Urine, slight cloud of albumen.

Treatment.—The patient received quinine from the commencement, and the temperature fell at once.

This patient had been in Forcados Prison since 21st March, 1913.

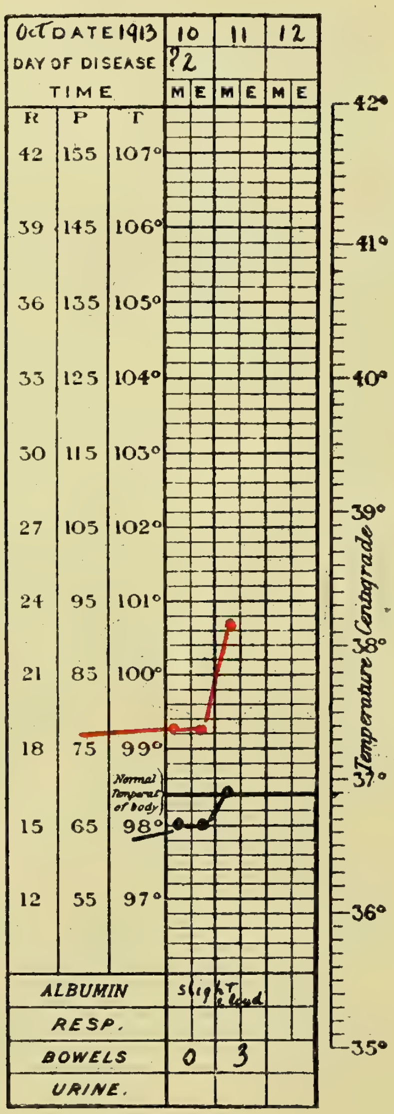


Chart 54

CASE 43. *Commission number not obtainable*

Race: Negro.

Age: 28.

Sex: Male.

Occupation: Prisoner.

Date of admission to hospital: 11th October, 1913.

Date of discharge: 15th October, 1913.

History.—The patient was on transfer from Onitsha to Lagos Prison. Brought to hospital on account of 'fever' in the night.

Condition on admission.—Temperature, 101° Fahr. Pulse, 96. Eyes, slightly injected. Tongue, moist; slight white fur. Chest, negative. Abdomen, spleen just palpable, tender. Urine, very slight cloud of albumen made out with great difficulty on 14th.

Treatment.—Quinine 5 grains t.d.s.

Paraplasma flavigenum found at Medical Research Institute, Yaba.

This patient was on his way from Onitsha to Lagos Prison. He would not have been lodged in Forcados Prison more than, at most, four days.

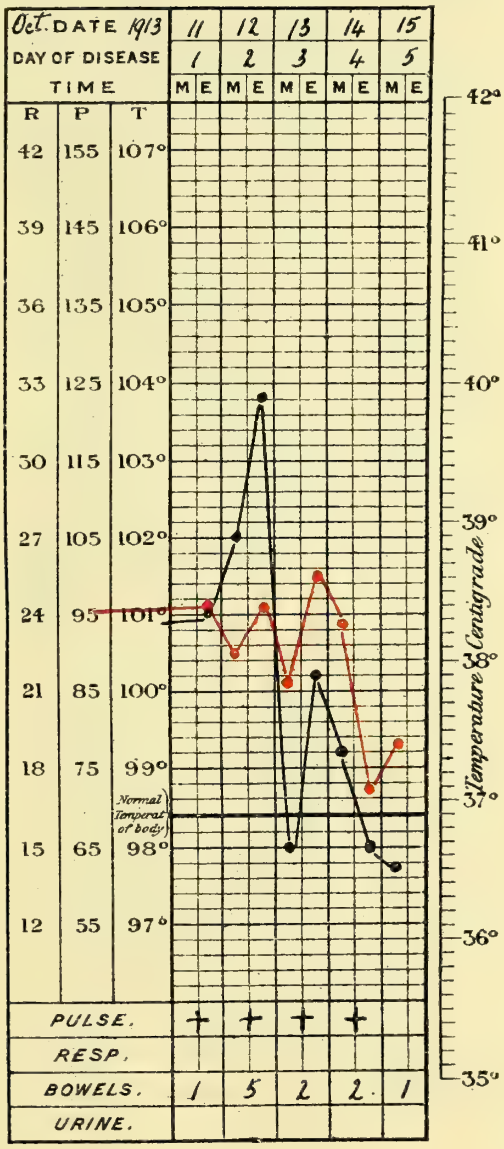


Chart 55

CASE 44. *Commission number not obtainable*

Race: Negro.

Sex: Male.

Age: 28.

Occupation: Engineer.

Date of admission to hospital: 15th October, 1913.

Date of discharge: 18th October, 1913.

History.—Began to feel ill on morning of 13th October, but went to work. Did not work on 14th. Had pain in eyes and left side, and says he had strong fever on night of 14th.

Condition on admission.—Examination negative, except that spleen is enlarged below the ribs and is tender. Liver slightly tender; not enlarged. Urine, slight cloud albumen.

Paraplasma flavigenum not found at Medical Research Institute, Yaba.

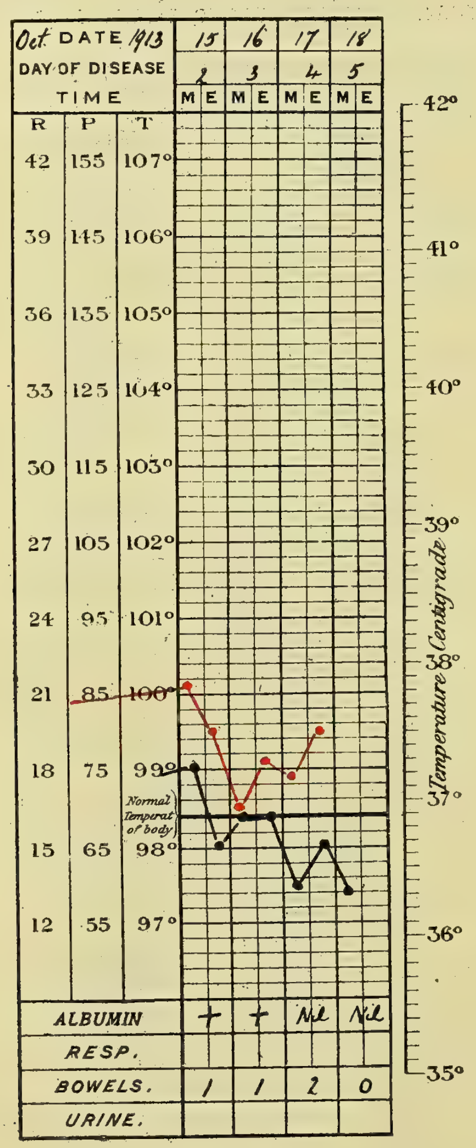


Chart 56

CASE 45. *Commission number not obtainable**

Race: Negro.

Age: 34.

Sex: Male.

Occupation: Clerk.

Date of admission to hospital: 15th October, 1913.

Date of discharge: 18th October, 1913.

History.—Nil.

Condition on admission.—Headache. Slight pyrexia, 99·2° Fahr. Pulse, 80. Urine, cloud of albumen.

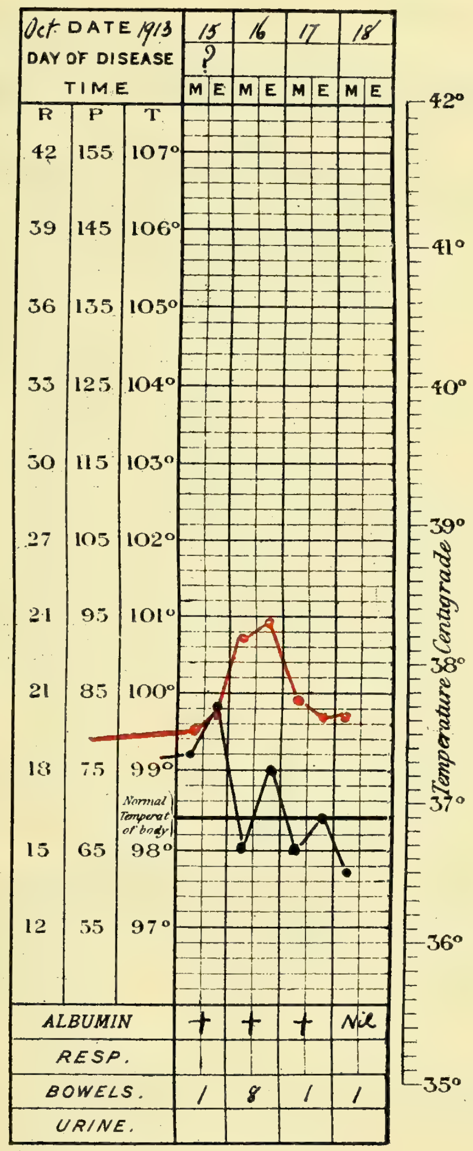


Chart 57

Case 46. *Commission number not obtainable*

Race: Negro.

Age: 16.

Sex: Male.

Occupation: Labourer.

Date of admission to hospital: 19th October, 1913.

Date of discharge: 27th October, 1913.

History.—Taken off s.s. 'Effo' on sixth day of inspection after fumigation from Lagos.

Condition on admission.—Temperature, 102° Fahr. Pulse, 90. Eyes, not injected. Tongue, red, slight white fur. Chest and abdomen, negative. Urine, albuminous.

Paraplasma flavigenum not found at Medical Research Institute, Yaba.

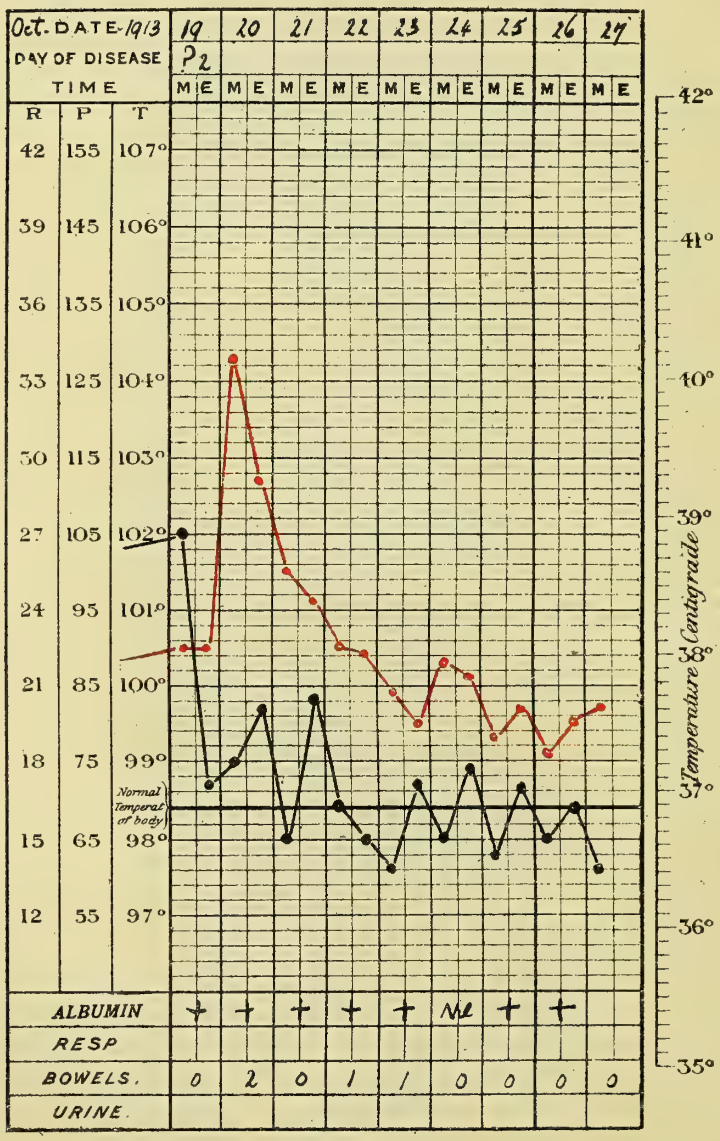


Chart 58

CASE 47. *Commission number not obtainable*

Race: Negro.
Age: 29.
Sex: Male.
Occupation: Labourer.
Date of admission to hospital: 20th October, 1913.
Date of discharge: 29th October, 1913.

History.—Admitted from s.s. 'Abonnema' from Lagos on the sixth day after arrival at Forcados. The vessel had been fumigated on arrival. Taken ill with headache on the night before admission.

Condition on admission.—Temperature, 103·8° Fahr.; no signs discovered to account for temperature. Pulse, 130. Eyes, not injected. Tongue, red, slight white fur. Respiration, rapid; no cough; snuffing nose. Chest and abdomen, negative. Urine, no albumen.

Course: 21st October.—Now complains of pain in lumbar region. Bilious vomit in the night.

23rd October.—Light cloud of albumen on boiling. Bronchitic signs both lungs behind. Still complains of lumbar pain.

Paraplasma flavigenum not found at Medical Research Institute, Yaba.

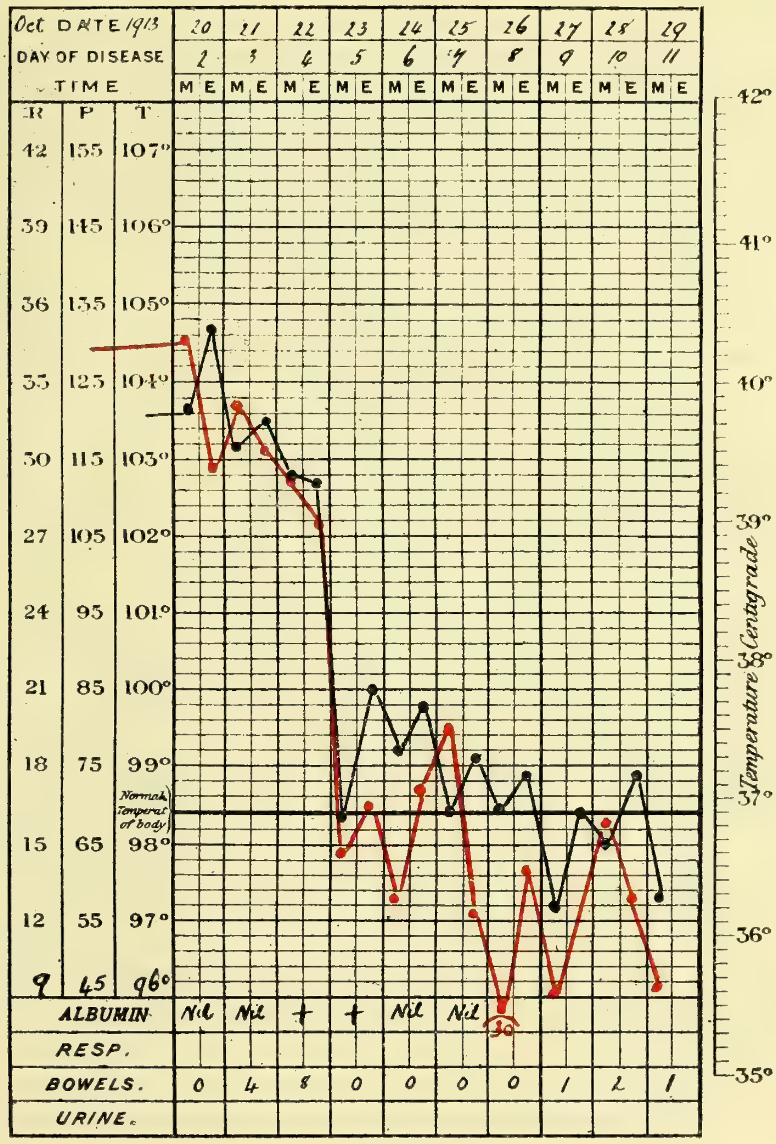


Chart 59

Case 48. *Commission number not obtainable*

Race : Negro.
Age : 38.
Sex : Male.
Occupation : Fireman, s.s. 'Iddo.'
Date of admission to hospital : 21st October, 1913.
Date of discharge : 3rd November, 1913.
Diagnosis : Phthisis.

Note.—Paraplasma flavigenum found at Medical Research Institute, Yaba.

History.—Admitted from s.s. 'Iddo' on the fourth day after her arrival from Lagos. The vessel had been fumigated on arrival at Forcados. Ill three days. Cough causing pain in right axilla.

Condition on admission.—Temperature, 102·6° Fahr. Pulse, 112. Eyes, rather yellower than usually seen. Tongue, natural. Abdomen, negative. Chest, a good deal of cough ; note at right base not so good as left, but nothing definite made out. Urine, slight cloud of albumen.

Course : 25th October.—Distinct pneumonic patch about three inches in diameter on fourth rib in front right side, with crepitations in right axilla.

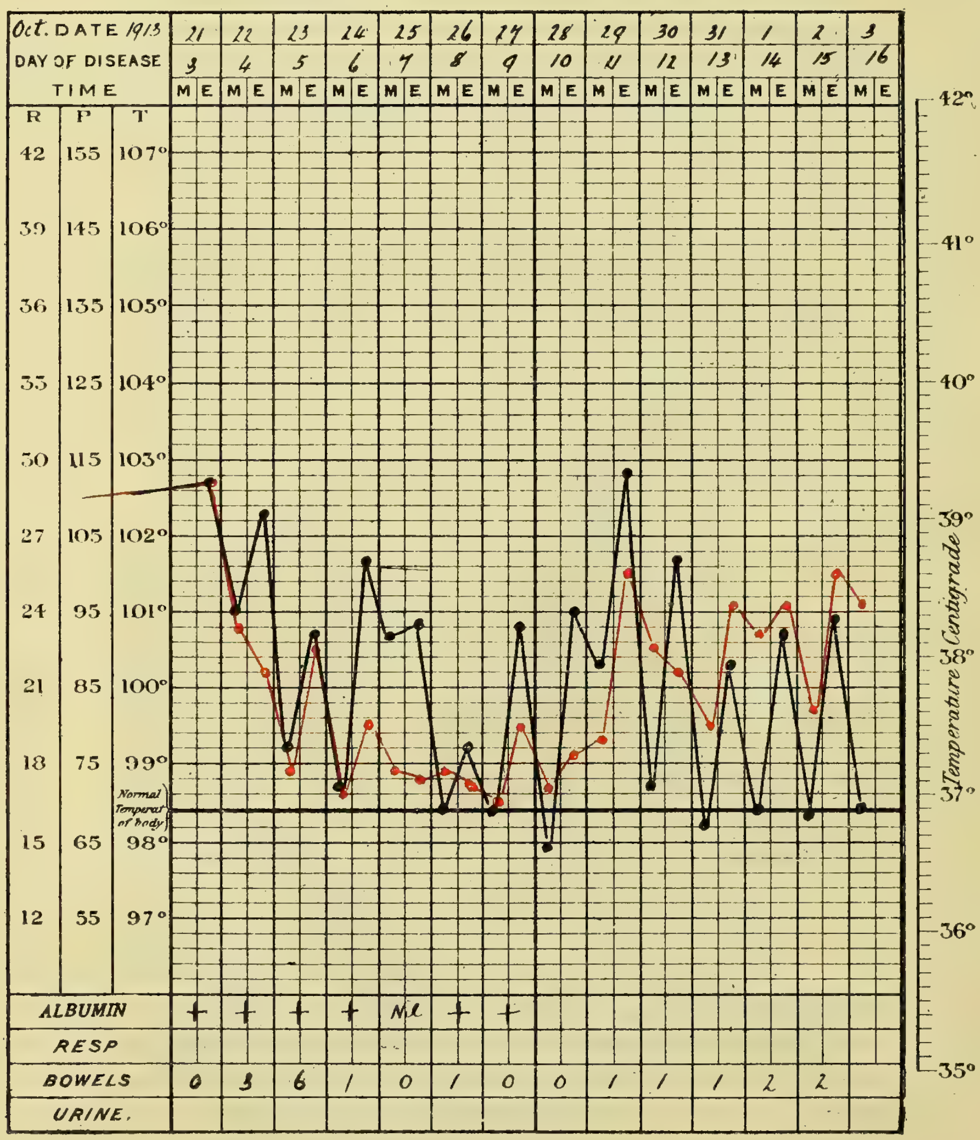


Chart 60

Case 49. L. 100†

Race: Negro.
Age: 24.
Sex: Male.
Occupation: Labourer.
Date of admission to hospital: 26th October, 1913.
Date of discharge: 13th November, 1913.

Living in Kroo House, Messrs. Elder Dempster's beach, in infected area. Was well on 25th October at one o'clock, had headache during the night and at one o'clock p.m., 26th, was found at inspection to have a temperature of 103°, with thick deposit of albumen in urine. He was isolated. Eyes were not injected. Tongue red, glazed, some white fur down both sides. Chest negative, except for a few bronchitic râles. Abdomen, no epigastric tenderness. Spleen one inch below the ribs, otherwise no signs.

27th October.—Temperature had risen to 104° last night, but down this morning to 99°. Urine as before.

28th October.—Temperature 99°. Urine as before. Half albumen after standing four hours. Casts found pretty plentifully in centrifugalized specimen—no blood—no pus.

13th November.—Albumen gradually diminished. Merest trace to-day. Patient discharged well.

Paraplasma flavigenum found at Medical Research Institute, Yaba.

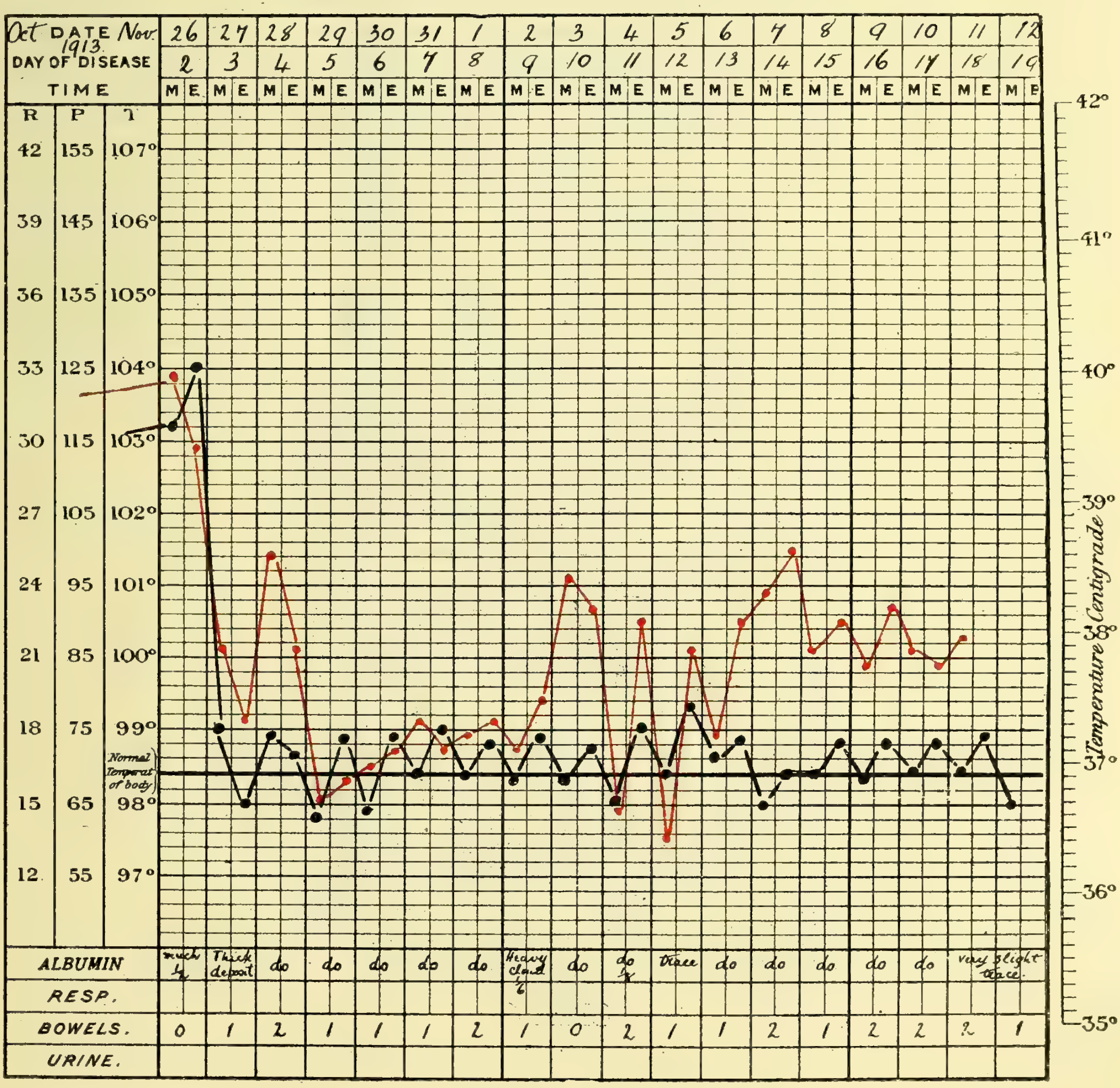


Chart 61

CASE 50. *Commission number not obtainable*

Race: Negro.

Sex: Male.

Age: 25.

Occupation: Prisoner.

Date of admission to hospital: 27th October, 1913.

Date of discharge: 1st November, 1913.

Diagnosis: Bronchitis.

Note.—*Paraplasma flavigenum* found at Medical Research Institute, Yaba.

History.—Slight fever evening of 26th. Temperature 100° Fahr. Has had fever for three days and been constipated. Is very deaf—history not reliable.

Condition on admission.—Temperature, 99·4° Fahr. Pulse, 82. Has some cough—a cold in the head. Chest, negative. Abdomen, spleen enlarged. Urine, albuminous.

Treatment.—Quinine 10 grains t.d.s.

This patient had been in Forcados Prison since 9th May, 1913.

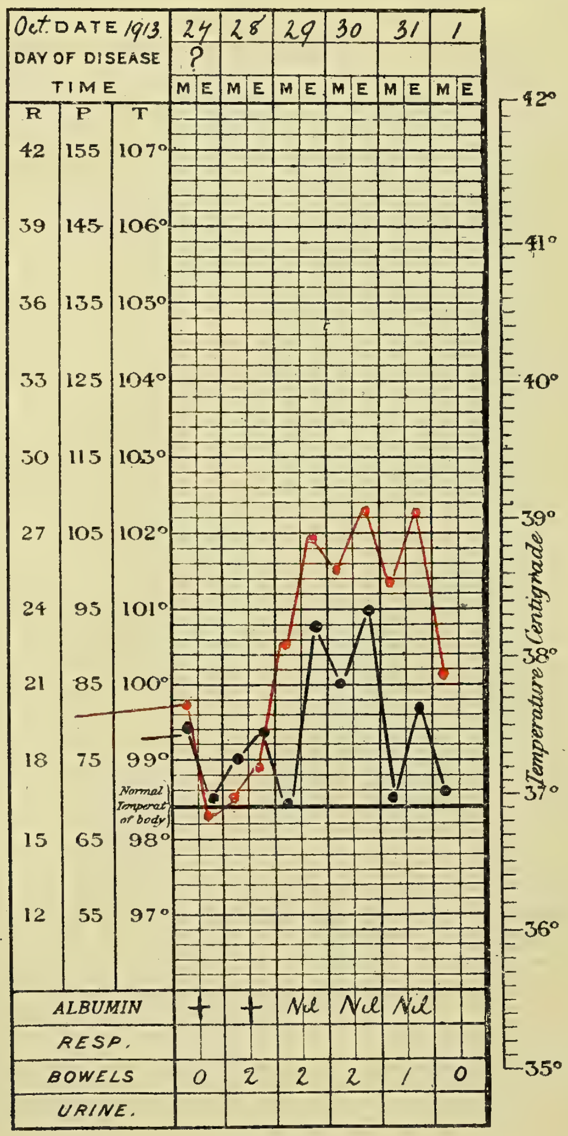


Chart 62

CASE 51. *Commission number not obtainable**

Race: Negro.

Age: 20.

Sex: Male.

Occupation: —.

Date of admission to hospital: 14th November, 1913.

Date of discharge: 18th November, 1913.

History.—Admitted for headache, etc. Vomited last night and had pain in abdomen.

Condition on admission.—Temperature, 100·2° Fahr. Pulse, 86. Eyes, distinctly jaundiced. Tongue, clean. Chest, negative. Abdomen, liver palpable; spleen comes below ribs; pressure at any point is said to be painful. Urine, high-coloured; bile; thick clot of albumen.

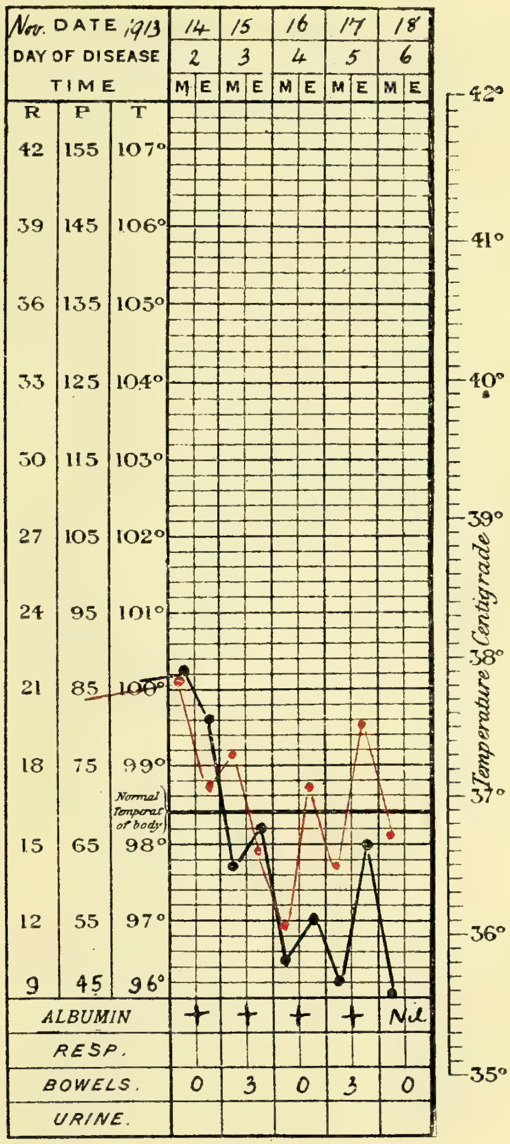


Chart 63

Case 52. *Commission number not obtainable**

Race: Negro.

Age: 23.

Sex: Male.

Occupation: Labourer.

Date of admission to hospital: 25th November, 1913.

Date of discharge: 29th November, 1913.

History.—The patient on arrival at Forcados by river boat from 'up country' (place of embarkation unknown) was found to have some pyrexia and was accordingly placed under observation.

His condition was as follows.—Abdomen, normal; no enlargement of liver or spleen. Tongue, quite clean. Urine, trace of albumen.

Course.—27th November.—Looked and felt quite well.

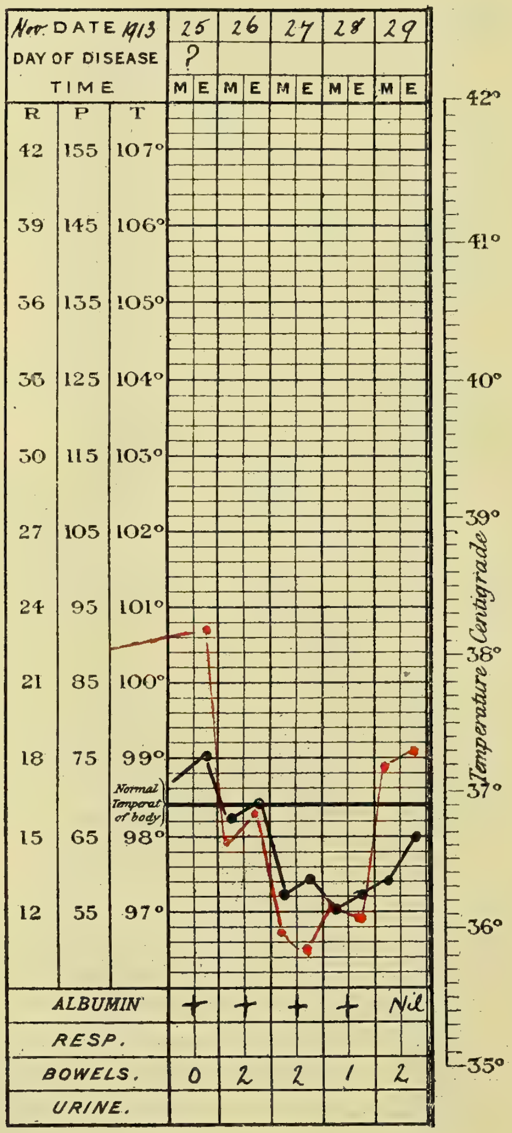


Chart 64

CASE 53. *Commission number not obtainable**

Race: Negro.

Age: 23.

Sex: Male.

Occupation: Labourer.

Date of admission to hospital: 25th November, 1913.

Date of discharge: 29th November, 1913.

History.—The patient on arrival at Forcados by river boat from 'up-country' (place of embarkation unknown) was found to have some pyrexia and was accordingly placed under observation.

Condition on admission.—Temperature, 100·2° Fahr. Pulse, 98. Tongue, clean. Abdomen, normal; slight enlargement of spleen; no jaundice, pain or vomiting. Urine, slight albumen.

Course: 27th November.—Feels quite well.

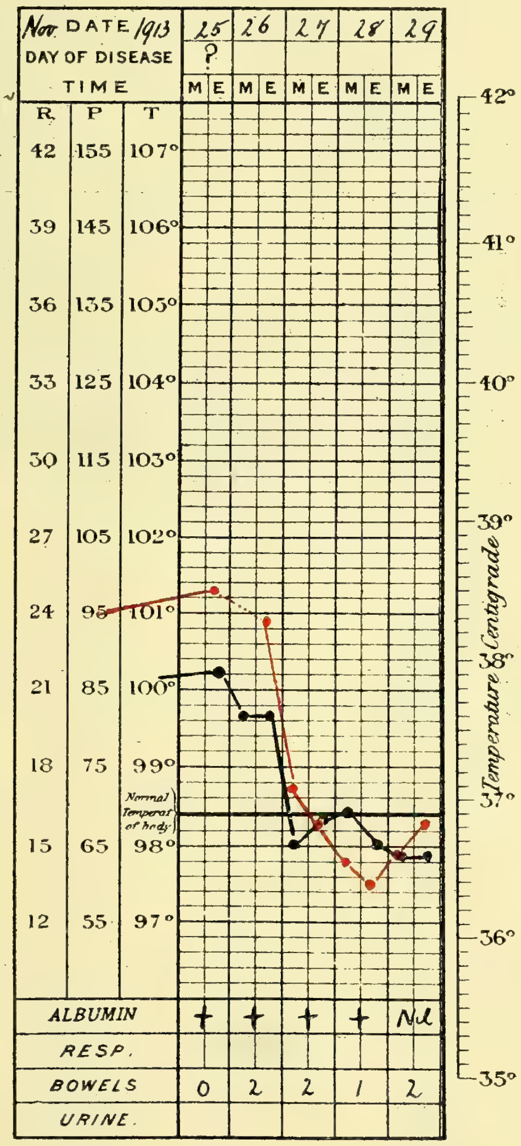


Chart 65

Tabular Statement of the Cases

Place	No. of Case in Report	Commission No.	Race	Approximate Age	Occupation	Date	Result	Quinine Prophylaxis	Blood Examination for Malaria Parasites	Blood Examination for *Paraplasma flavigenum*	Remarks
						1909					
Forcados	1	L.7	European	—	Government official	Oct.; date unknown	Recovery	Not known	No record	—	—
,,	2	L.10	,,	—	,, ,,	Nov. 22—29... ...	,,	,,	,,	—	—
,,	3	L.9	,,	—	,, ,,	Nov. 23—Dec. 1 ...	,,	,,	,,	—	—
,,	4	L.8	,,	—	,, ,,	Nov. 16—21... ...	Death	,,	,,	—	—
						1911					
,,	5	L.6	Negro	—	Water Policeman	Aug. 26—Sept. 4 ...	Recovery	No	Negative	—	—
						1913					
Burutu ...	6	L.11	,,	30	Engineer	Jan. 22—Feb. 13 ...	,,	,,	,,	—	—
,,	7	L.12	,,	26	Labourer	Feb. 19—Mar. 18 ...	,,	,,	,,	—	—
,,	8	†	,,	—	,, ...	Mar. 3—April 11 ...	Death	,,	Not made	—	Otitis Media (? following fever unclassified).
,,	9	L.3	,,	—	,, ...	Mar. 5—13	Recovery	,,	Negative	—	—
,,	10	L.2	,,	29	,, ...	Mar. 4—15	,,	,,	,,	—	—
,,	11	L.1	,,	26	,, ...	Mar. 4—18	,,	,,	,,	—	—
,,	12	L.4	,,	18	,, ...	April 5—16	,,	,,	,,	—	—
,,	13	?	,,	—	,, ...	April 7—16	,,	,,	Not made	—	Pneumonia (? fever unclassified)
,,	14	†	,,	—	,, ...	April 7—16	,,	,,	,,	—	,,
,,	15	†	,,	—	,, ...	April 7—24	,,	,,	,,	—	,,
,,	16	L.13	,,	29	,, ...	April 8—18	,,	,,	Negative	—	—
,,	17	L.5	,,	16	,, ...	April 23—26 ...	Death	,,	,,	—	—
,,	18	?	,,	—	,, ...	April 24—May 2 ...	Recovery	,,	,,	—	—
,,	19	?	,,	—	,, ...	May 8—18	,,	,,	,,	—	—
,,	20	L.60	,,	26	Pauper	July 9—16	,,	,,	,,	—	No albuminuria
,,	21	L.62	,,	29	Labourer	July 31—Aug. 9 ...	,,	,,	,,	Positive	—
Forcados	22	?	,,	—	Fireman	May 5—18	,,	,,	,,	—	—
,,	23	L.61	,,	27	Labourer	July 24—30	,,	,,	,,	—	—
,,	24	L.74	,,	24	,, ...	Aug. 29—Sept. 2 ...	,,	,,	,,	—	—
,,	25	L.80	,,	12	Pauper	Sept. 3—8	,,	,,	,,	—	—
,,	26	L.75	,,	17	Labourer	Sept. 4—9	,,	,,	—	—	—
,,	27	L.76	,,	13	Schoolboy ...	Sept. 5—9	,,	,,	—	—	—
,,	28	L.77	,,	22	Clerk	Sept. 8—11	,,	—	—	—	—

The sign (†) signifies that the notes of the case were not submitted to an Investigator.
The question mark (?) signifies that the Commission number was unobtainable.

TABULAR STATEMENT OF THE CASES—*continued*

Place	No. of Case in Report	Com-mission No.	Race	Approxi-mate Age	Occupation	Date	Result	Quinine Prophy-laxis	Blood Examination for Malaria Parasites	Blood Examination for *Paraplasma flavigenum*	Remarks
						1913					
Forcados	29	L.78	Negro	16	Pauper	Sept. 9—17 ...	Recovery	No	—	—	—
,,	30	L.79	,,	26	Servant	Sept. 12—17 ...	,,	,,	—	—	—
,,	31	L.97	,,	24	Labourer	Sept. 22—30 ...	,,	,,	—	—	—
,,	32	L.96	,,	22	,, ...	Sept. 23—28 ...	,,	,,	—	—	—
,,	33	L.95	,,	23	Engineer	Sept. 25—28 ...	,,	—	—	—	—
,,	34	L.99	,,	24	Clerk	Sept. 26—28 ...	,,	—	—	Positive	—
,,	35	L.94	,,	—	Labourer	Sept. 26—30 ...	,,	No	—	—	—
,,	36	L.98	,,	24	Female pauper ...	Sept. 26—Oct. 3 ...	,,	,,	Positive	—	—
,,	37	L.93	,,	—	Labourer	Sept. 23—26 ...	,,	,,	—	Positive	—
,,	38	L.92	,,	—	—	Oct. 3—7 ...	,,	,,	—	—	No albuminuria Patient treated with quinine
,,	39	†	,,	28	Clerk	Oct. 8—9	,,	—	—	—	The albuminuria was considered to be ‘cyclical’
,,	40	?	,,	26	Prisoner	Oct. 9—15	,,	No	—	Positive	Patient treated with quinine
,,	41	?	,,	21	Labourer	Oct. 10—18	,,	,,	—	—	—
,,	42	?	,,	24	Prisoner	Oct. 10—11	,,	,,	—	—	Patient treated with quinine
,,	43	?	,,	28	,, ...	Oct. 11—15	,,	,,	—	Positive	,,
,,	44	?	,,	28	Engineer	Oct. 15—18	,,	,,	—	Negative	—
,,	45	?	,,	34	Clerk	Oct. 15—18	,,	—	—	—	—
,,	46	?	,,	16	Labourer	Oct. 19—27	,,	No	—	Negative	—
,,	47	?	,,	29	,, ...	Oct. 20—29	,,	,,	—	,,	—
,,	48	?	,,	38	Fireman	Oct. 21—Nov. 3 ...	,,	,,	—	Positive	Phthisis pulmonalis was diagnosed in this case
,,	49	L.100	,,	24	Labourer	Oct. 26—Nov. 13 ...	,,	,,	—	,,	—
,,	50	?	,,	25	Prisoner	Oct. 27—Nov. 1 ...	,,	,,	—	,,	—
,,	51	?	,,	20	—	Nov. 14—18... ...	,,	,,	—	—	—
,,	52	?	,,	23	Labourer	Nov. 25—29... ...	,,	,,	—	—	—
,,	53	?	,,	23	,, ...	Nov. 25—29... ...	,,	,,	—	—	—

The sign (†) signifies that the notes of the case were not submitted to an Investigator.
The question mark (?) signifies that the Commission number was unobtainable.

SYNOPSIS OF CASES

The onset was gradual in Cases 2, 3, 4, 6, 7, 9, 10, 11, 12, 13, 19, 20, 21, 22, 23, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 41, 44, 46, 47, 48, 49, 50, 51; unknown in Cases 1, 5, 8, 14, 15, 16, 17, 18, 24, 40, 42, 43, 45, 52, 53.

The fever.—Faget's sign* was present in Cases 36 and 43. Its presence was doubtful in Cases 23, 24, 32, 35, 37, 46, 47. The fever, as shown in the temperature charts, may be classified into two main types:—(*a*) Descending; (*b*) Remitting.

(*a*) Descending type.—Cases 5, 7, 13, 14, 18, 22, 23, 24, 25, 26, 27, 28, 29, 30, 32, 37, 38, 40, 41, 43, 46, 47, 49, 51, 53.

(*b*) Remitting type.—Cases 1, 2, 3, 4, 6, 8, 9, 10, 11, 12, 15, 16, 19, 20, 21, 31, 48, 50.

In the following cases insufficient data make classification impossible.—Cases 17, 33, 34, 35, 36, 39, 42, 44, 45, 52.

The face was described as 'fallen in' in Case 8.

The eyes were injected, or slightly injected, in Cases 5, 10, 11, 12, 18, 24, 28, 32, 38, 42, 43; doubtfully injected in Case 35; not injected in Cases 9, 21, 22, 23, 26, 27, 29, 30, 31, 33, 34, 36, 37, 40, 41, 46, 47, 49; 'not the least injected' in Case 39. The eyes were painful with (?) slight injection in Case 35; 'puffy' in Case 17, 'heavy-eyed' in Case 25. They were jaundiced in Cases 13, 51; 'rather yellower than usually seen' in Case 48. Jaundice is noted to be absent in Cases 2, 3, 5, 6, 7, 10, 17, 22.

(Dr. Bailey remarks in his cover to half-yearly return of suspicious cases 1913.—'Jaundice in slight degrees was not accepted, as it is almost the rule in healthy persons.')

The pupils.—

The skin.—A rash is noted in Cases 2, 3 (these patients were Europeans).

The Nervous System

Cerebral symptoms.—Prostration is noted in Cases 2, 5, 6, 7, 13, 14; delirium in Case 4 on second day, but usually quiet and apathetic in Case 17; mania and convulsions at the end in Case 4.

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* The definition of this sign was taken to be as follows:—A want of co-ordination between pulse-rate and temperature showing a falling pulse-rate with a rising or horizontal temperature curve.

Disorders of sensation.—Deafness (no quinine given) was marked in Cases 10, 11; slight in Case 12; so severe as to be useless for any history, but cleared up later, in Case 16. Case 50 is noted as being very deaf on admission. Case 17 was 'admitted in a sleepy state.'

Pain.—Headache is noted in Cases 4, 23, 26, 27, 31, 32, 34, 35, 36, 37, 41, 45, 47, 49, 51. Pain is noted in the eyes in Cases 35, 44; in the chest in Case 23; in the right axilla, due to cough, in Case 48; over the sternum in Case 20; in the abdomen in Case 27—said to be painful all over, but not tender on pressure—also in the abdomen in Case 51—pressure at any point said to be painful; in the epigastrium in Case 31; about the shoulders and other joints in Case 7; in the soles of the feet—severe burning—in Case 6; in joints, previous to admission, in Cases 31, 36, 'all over the body' previous to admission, on admission all over neck, back and arms, in Case 9; in the limbs in Case 15; in the left side in Case 44; in the back in Cases 2 (violent), 3, 15, 37 (over top of sacrum), 47 (in lumbar region). Tenderness over the liver is noted in Cases 5, 6, 12. Epigastric tenderness is noted to be absent in Case 49.

Digestive System

The mouth.—Foetor of the breath was present in Cases 10, 35, 37; the mouth was 'dirty' in Case 20.

The tongue.—Was furred in Cases 2, 3, 5, 7, 10, 16, 18, 19, 21, 35, 37; clean in Cases 23, 24, 28, 29, 30, 31, 40, 42, 51, 52, 53; fairly clean in Cases 9, 33, 34, 36, 43, 46, 47; clean at the edges in Cases 11, 12, 20, 25, 26, 27, 32; red, glazed, some white fur down both sides in Case 49; pale and indented in Case 41; slightly tremulous in Case 31; indented in Case 35; there was yellow fur, said to be habitual, on dorsum in Case 39.

The stomach.—Slight bilious vomiting is noted in Cases 2, 3, 4 (Europeans). Bilious vomiting is noted in Case 47 (native). Absence of vomiting is noted in Cases 5, 6, 7, 9, 10, 17, 22. There had been sea-sickness previous to admission in Case 39. There had been vomiting on the night preceding admission in Case 51.

The liver.—Was enlarged in Cases 5, 6, 12, 17, 27; tender in Cases 5, 6, 12; slightly tender, not enlarged, in Case 44; palpable in Cases 18, 19, 22, 23, 36, 51; on very deep expiration in Case 39;

'hardened' in Cases 18, 19; not enlarged or tender in Cases 9, 10, 11, 13, 20, 23, 24, 25, 26, 28, 30, 31, 32, 34, 35; not enlarged in Case 52.

The stools.—Constipation is noted in Cases 19, 50. The stools are noted to be normal in Case 9.

Renal System

The urine.—As already mentioned, the measurements given of the total quantity of urine excreted are probably inaccurate, and they are, therefore, not quoted here. The renal crisis which occurred in Case 11 is, however, authentic. Albuminuria was present in all Cases except Nos. 1, 2, 3, 4, 20, 37. Casts were found in Case 49. Bile was present in Case 51.

Respiratory System

The chest was noted to be 'filled up' in Case 8. The respirations were noted as 'hurried, about 45, a few bronchitic sounds in the lungs,' in Case 11; as 'rapid; no cough' in Case 47. Pneumonia was present in Cases 13 (apical), 14 (apical), 15 (basal). There were 'slight bronchitic sounds' in Case 23, 'a few bronchitic râles' in Case 49; 'some crepitations with slight cough, no dullness' in Case 29; slight cough in Case 31; 'some crepitations at right base, no cough acknowledged or heard' in Case 35. A diagnosis of phthisis was made in Case 48. The nose was noted as 'snuffling' in Case 47.

The Circulatory System and Ductless Glands

The heart.—A slight systolic murmur at the apex, not conducted, is noted in Case 37.

The pulse (see also Faget's sign, under fever) was slow in proportion to the temperature in Cases 3, 5, 10, 11, 16, 20, 21, 22, 23, 38, 43; slow during convalescence in Cases 2, 3, 5, 7, 8, 9, 11, 13, 14, 18, 19, 21, 22, 25, 26, 27, 28, 29, 30, 32, 34, 35, 53; rapid, out of proportion to the temperature, in Cases 17, 36.

The spleen was noted to be 'hard' in Case 8; tender in Cases 43, 44; not tender in Case 8; enlarged in Cases 8, 9, 12, 16, 17, 19, 21, 26, 27, 29, 43, 44, 49, 50, 51, 53.

Notes of the Movements Previous to Illness of Cases 6, 20, 21, 25, 28, 31, 35, 39, 43, 46, 47, 48, 52, 53, the only patients of the 1913 series who are known to have been away from Forcados or Burutu shortly before admission to hospital.

Case 6.—This patient was an engineer on one of the Niger Company's 'stern-wheelers,' plying between Forcados (Burutu) and Baro (Northern Nigeria), and touching at various intermediate ports. The journey from Forcados to Onitsha occupies about two days. Between Onitsha and Baro the patient began to suffer from 'fever,' and another engineer on the vessel was also sick with (apparently, according to the patient) the same kind of 'fever.' This other man deserted during the return voyage, but the patient presented himself for treatment at Forcados upon his return, giving a history of three weeks' illness.

Case 20.—This patient lived in the native town of Okorodudu, about one quarter mile from Burutu, and was employed on the Government 'beach' at the latter place.

Case 21.—This patient was one of the crew of the launch 'Sandbeek.' On the 13th July the vessel left Burutu for Onitsha and arrived again at Burutu on the 23rd July. He was admitted to hospital on the 31st July on (?) the fourth day of the illness. As the launch had meanwhile sailed again to Onitsha the Medical Officer at that place was communicated with by telegraph and reported that there were no others sick on board, nor was any case of sickness found to have occurred upon her return to Burutu. The patient's residence at Burutu was unknown.

Case 25.—This patient came from Gwangaw, near Warri, but, on admission, had been in Forcados for two weeks.

Case 28.—This patient had been on board the mail-boat 'Karina' at Forcados and Burutu for one week. He then went ashore (about the 5th September) and lived near to where Cases 25, 26, and 27 occurred. These cases were admitted to hospital on the 3rd, 4th, and 5th September respectively. He was admitted on the 8th September—the third day of the disease. The 'Karina' had arrived at Forcados on 30th August, having come from Liverpool. She had anchored in the harbour at Sierra Leone; at other West

Coast ports she lay in the roads; numerous deck passengers (natives) were carried between Sierra Leone and Forcados.

There were no suspicious cases on the vessel either before or subsequently to this case so far as I have been able to ascertain.

It is, of course, very possible that the patient went ashore during his week's sojourn on the ship at Forcados and Burutu, notwithstanding his statement to the contrary. At Forcados the vessel was anchored in the river, but at Burutu she was moored to the wharf.

Case 31.—This patient was one of the crew of the dredger 'Egerton,' which arrived at Forcados on 30th August, having left Lagos while that town was in quarantine for yellow fever. She was fumigated on arrival, after which the patient lived on board for one week, *i.e.*, until the 6th September. He then lived ashore (see 'spot' map of Forcados). He was admitted to hospital on the 22nd September—the fourth day of his illness.

Case 35.—This patient was a fireman on the station-launch 'Aro,' on which he would frequently be at work after nightfall. He had lived at Chikoko Beach (see 'spot' map of Forcados) for three years, in a 'bush' house.

Case 39.—This patient had arrived at Forcados from Lagos by the s.s. 'Niger' on the day preceding his admission to hospital. Lagos was at this time (October) in quarantine. (See Section III, Case 21.)

Case 43.—This patient was a prisoner who was being transferred from Onitsha to Lagos Gaol, and was temporarily lodged in Forcados Prison. At the time of his illness he would not have been in Forcados more than four days. He may have become infected either on the river-boat between Onitsha and Forcados or (as the journey occupies only two days) at Onitsha. The fact that three other cases—Nos. 40, 42, and 50—occurred in the prison at Forcados about the same date is, however, suggestive. There had been no suspicious cases among the prisoners at Onitsha.

Cases 46, 47, and 48 were taken off three different vessels that had come from Lagos while that town was in quarantine. (See Section III, Cases 22, 23, and 24.)

Cases 52, 53 had arrived at Forcados by river launch from 'up-country'—place of embarkation unknown.

It will be seen that, of the above cases, Nos. 6, 20, 21, 25, 28, 31, 35, 43, may have become infected ashore at Forcados or Burutu.

Clinical Note

The remarks by Dr. Bailey (see above), refer to the clinical features of those cases which occurred before June, 1913. They are equally applicable, with certain exceptions that are apparent, to those which were treated after June, and it would hence be superfluous for me to discuss the cases further.

I, therefore, refer here only to Cases 14 and 15, which occurred in April, and were not included in Dr. Bailey's January to June series.

Both presented pneumonic signs, which, it may be remarked, were also present in patient No. 13.

Case 14.—The persistence of 'much' albumen in the urine for four days after the temperature had fallen to normal is interesting. Was there in this case, perhaps, a double infection (pneumonia and yellow fever)? As already stated, the record of respirations, made by a native attendant, is untrustworthy.

Case 15.—The pains in the limbs and back are suggestive, as also is the fact that three other cases (Nos. 10, 11, 12) had been admitted to hospital from the same house in which the patient lived at Burutu (see 'spot' map) on 4th March, 4th March and 5th April respectively. The patient was (as also were Cases 13, 14) admitted to hospital on 7th April. The pneumonic signs in Cases 13, 14 were apical; in Case 15 they were basal.

Epidemiological Note

The similarity of the clinical characters in the majority of the 1913 cases, taken together with their chronological and topographical features, appears to leave little room for doubt as to their infective nature.

With the possible exception of Cases 1, 2, 3, 37, 38 (all without albuminuria), it appears improbable that they were either dengue or seven-day fever.

No exceptional development of *Stegomyia* was associated with any of the cases except Nos. 10, 11, 12, 15, which occurred in the same house at Burutu. The first three of these are fairly typical of the whole series.

This association with an unusual number of *Stegomyia*, while it is no actual proof, is, of course, very suggestive of their specific nature.

If these cases and the similar ones which have occurred at Lagos were not yellow fever in a modified form, it would be necessary to invoke the 'long arm of coincidence' in order to explain their occurrence during the same period as well-marked cases of the disease in Europeans and Syrians in Lagos, Warri, Abeokuta, and on certain ocean-going vessels. And in this connexion it may be remarked that the occurrence of the Forcados and Burutu cases, with the exception of Nos. 46, 47, 48, 52, 53, was in no way an artificial or misleading occurrence in the sense that the patients were persons examined in the course of quarantine work, who would have otherwise escaped detection. On the contrary, all the Forcados and Burutu cases, with the exceptions stated, voluntarily applied for treatment. The cases, excluding those of 1909 and 1911, fall into two groups: (i) the Burutu cases, which occurred between January and July; (ii) the Forcados cases, which occurred from May to November.

(i) Burutu cases.—These were 16 in number. One case occurred in January, one in February, four in March, seven in April, one in May, and two in July.

None had, as far as could be ascertained, been away from Burutu for some weeks previous to the illness, with the exception of Nos. 6, 20, and 21, whose movements have already been considered in detail.

Cases 10, 11, 12, 15 lived in the same house (25 per cent. of all the Burutu cases); they were admitted to hospital respectively on 4th March, 4th March, 5th April and 7th April.

Cases 9 and 13 lived within approximately 60 yards of one another, and within approximately 160 yards of Cases 10, 11, 12, 15.

Cases 9 and 13 were admitted to hospital respectively on 5th March and 7th April. The residence of Cases 6, 8, 14, 16, 18, 19, 21 is unknown.

(ii) Forcados cases.—These were 32 in number. One case occurred in May, none in June, one in July, one in August, thirteen in September, thirteen in October, and three in November. None had, as far as could be ascertained, been away from Forcados for some weeks previous to their illness, with the exception of Cases 25, 28, 31, 35, 39, 43, 46, 47, 48, 52 and 53, whose movements have already been considered in detail.

Cases 22, 25, 26, 27, 28, 33, 34, 36, 38, 41, 45 occurred in one definite area (see 'spot' map). They were admitted to hospital on the following dates:—

Case 22	5th May.
,, 25	3rd September.
,, 26	4th ,,
,, 27	5th ,,
,, 28	8th ,,
,, 33	25th ,,
,, 34	25th ,,
,, 36	26th ,,
,, 38	3rd October.
,, 41	10th ,,
,, 45	15th ,,

Cases 25 and 28 were probably infected in Forcados, though they had been away from the port within a short period of their illness.

Cases 29, 31, 32, 49 occurred in Messrs. Elder Dempster and Company's compound on respectively 9th September, 22nd September, 23rd September, 26th October.

The residence of Cases 44 and 51 is unknown. Of the four cases 40, 42, 43, 50, which occurred in the prison, three appear to be of special interest.

The four cases occurred respectively on 9th, 10th, 11th, and 27th October. They had been lodged in Forcados Gaol, respectively, eight months, six months, not exceeding four days, five months. It will be convenient to set out these facts in tabular form:—

Case No.	Date of Admission to Hospital	Length of Previous Incarceration
40	9th October	8 months
42	10th October	6 months
43	11th October	Not exceeding 4 days
50	27th October	5 months

Leaving out of consideration Case 43, who had been brought from Onitsha and may have become infected there or *en route* (as

already mentioned the journey from Onitsha to Forcados occupies two days), it is difficult to understand how, under the efficient sanitary conditions of Forcados gaol, the remaining three prisoners could have become infected. As will be seen from the attached plan of the town, the prison is situated in a very sparsely populated area, and some distance away from dwellings, with the exception of the jailor's, warders' and gang-drivers' houses. These I had thoroughly inspected shortly *before* the cases occurred (within a week of Cases 40, 42, and within three weeks of Case 50), and found to be well kept and quite free from larvae. Moreover, the prevailing wind blows *from* the prison *towards* the native quarter.

Prisoners are, of course, kept within the gaol from sunset to sunrise.

Assuming that yellow fever is produced by a protozoic organism, is it possible that, as in malaria, it may remain latent in the body until, stimulated into activity by some debilitating influence acting upon the host, there is a resulting exhibition of symptoms?

It would follow that an attack of yellow fever in a native need not, any more than an attack of malarial fever, connote a recent infection.

Such a view in regard to Europeans, it may be urged, would be untenable on the ground that yellow fever is not known except in traceable association with *Stegomyia fasciata*, and that if it were true, exacerbations of the disease would occur, as in the case of malaria, in regions where the insect carrier is unknown. In reply to this argument it might be said that such exacerbations in cold climates possibly do occur, being mistaken for malaria.

A European harbouring the yellow fever organism, and, therefore, perhaps, partially immunized, would conceivably develop atypical symptoms, the significance of which would escape recognition.

Typical attacks of yellow fever, analogous to those occurring in malaria, long after infection, need perhaps (in the present state of knowledge of immunity in its relation to protozoal diseases) not be assumed necessarily to occur.

As far as I am aware, the hypothesis here enunciated has not hitherto been suggested. I make it with all diffidence, and because

it is, of course, desirable to draw attention to a possibility the establishment of which as a fact would greatly modify the existing aspects of the disease.

Incidentally, the localization of the Forcados cases, whilst it is corroborative evidence of their nature, illustrates the desirability of European segregation. Eleven out of a total of thirty-two (34 per cent.) were grouped in one definite area (see map); four (12·5 per cent.) in another. Four cases occurred in the prison—one of these was possibly imported. The remaining cases were scattered, as also were those at Burutu, with the exception of four (25 per cent.), which occurred in the same house. In the absence of segregation, the risk, not only of infection of Europeans, but also of reinfection of natives with an organism of enhanced virulence, was very considerable. Doubtless anti-mosquito measures to the extent of totally exterminating *Stegomyia* would commend themselves to such as regard European segregation with disfavour, but those who have had practical experience of anti-mosquito measures in this Colony, while admitting the great importance of mosquito destruction, know well that a counsel implying total destruction is a counsel of perfection.

This is not the place to enter into a discussion of the relative merits of mosquito extermination and of race segregation, but whilst dealing with the Forcados and Burutu outbreak it appears desirable to point out, in relation to those ports, that the constant ingress and egress of launches and 'stern-wheelers,' in which *Stegomyiae* develop freely and may be transported from place to place, and of canoes in which there is frequently standing water, not to mention the frequent arrival and departure of ocean-going vessels, would render a scheme of prophylaxis against yellow fever, in regard to these towns, which did not include European segregation probably futile and certainly very unreliable.

VI. *Conditions as regard* Stegomyia *Breeding in Forcados and Burutu*

Stegomyia fasciata is present at both Forcados and Burutu.

The native houses in those towns are disposed on a definite plan. They stand, for the most part, in rows, are therefore easily

inspected, and only a small proportion of them have compounds (inclosures), in which, in other towns, one so frequently finds collections of standing water and agglomerations of garbage. It is to be remarked, however, that in some parts of Forcados, notably in the area where Cases 22, 33, 36, 38, 41 occurred, the sanitary conditions were deplorable, and due entirely, I was informed, to the want of financial means to carry out some most essential and even elementary improvements. I inspected both Forcados and Burutu, in which the conditions as regards *Stegomyia* breeding are similar, and the following statistics represent the sum of my observations in both places, made before any exceptional anti-mosquito measures had been taken.

Out of 115 houses taken at random in different parts of the towns, including those in which the cases described occurred, no water at all was found in 32, while in four larvae were found. These larvae, on being hatched out, proved to be *Stegomyia fasciata*.

My inspection, it should be remarked, was made at the termination of the rainy season, when the water supply is sufficient and there is no temptation to store it unduly inside the houses. The conditions which obtain in the dry season may possibly be less favourable, for, at that period of the year, I am informed, there is often a considerable shortage of water, which has then to be brought a long distance by river and economized as much as possible. This shortage, I am further informed, is due to the inadequate supply of rain-water tanks. I learned from the Medical Officer that the outbreak of four cases (Nos. 10, 11, 12, 15) in one house at Burutu was ascribable to the breeding of large numbers of *S. fasciata* in some barrels of water in the compound which had been overlooked by the Sanitary Inspector.

Out of fifteen wells I found that six were safely screened; in one the mosquito gauze was in disrepair; in one (upon private ground) no attempt at screening had been made, in one (upon Government property) *Stegomyia* larvae had been found according to the Sanitary Inspector. This well was unscreened and had since been oiled.

I examined 37 rain-water tanks. Of these 29 were effectively screened. In eight the gauze was defective. Out of 34 barrels

used for the storage of water, 15 were effectively screened, there was a defect in the gauze in 11, whilst 8 were open.

In seven roof-gutters there was some standing water. In none of the wells, tanks, barrels, or roof-gutters, whether screened or not, did I find any larvae whatever. The mosquito-index in Forcados, based on the observations of native sanitary inspectors in April, May, and June, 1913 (wet months), was 0·61, 0·46, 0·55, respectively.

In December, 1912, and January and February, 1913 (dry months), it was 0·27, 0·61, 1·06, respectively.

I inspected both the native villages, the nearest of which, as already stated, is about one furlong from a European residence (non-official).

These villages are situated amidst unreclaimed swamp. The huts, which, even in the dry season are practically surrounded by water, are built of reeds and are raised, some upon piles, others upon platforms of earth. They are connected with one another and with the town by raised paths which slope down to the water on either side through a zone of black mud. The picture presented is that of a diminutive, primitive, and infinitely hideous and squalid Venice. The water is, for the most part, tidal, and I found no larvae therein, but there are numerous ponds and pools where earth has been excavated to form platforms for houses. These are only reached by high tides, and in some (but in only one of the villages) I found an abundance of mosquito larvae.

Dr. Laurie, the Junior Sanitary Officer, had, I was informed, found some of these larvae to be *Stegomyia fasciata*, but though I collected and bred out a large number, none of them proved to belong to this species. His observation is, of course, of the highest importance as indicating a probable source of supply of this insect to Forcados port.

I obtained some of the water from the pond in question for analysis by the Government chemist, Mr. Ralston, in order that the degree of its salinity might be ascertained. He reported that the chlorides present were equivalent to 4·74 per cent. of common salt, and he informed me that, in a series of experiments carried out by him in 1904, he found that in water containing under 1 per cent. common salt mosquito larvae developed freely.

In consequence of the vigorous house inspection that had taken place in these villages, and the strict injunctions issued to the inhabitants concerning water storage prior to my visit, further examination would not have yielded any useful results.

Twenty houses, taken at random, contained no larvae; indeed, in a considerable proportion of these no water whatever was stored.

From consideration of the foregoing facts it would appear that the river craft, and perhaps also, as regards Forcados, the native villages, constitute the principal source of supply of *S. fasciata* in Forcados and Burutu.* As is well known, the insect breeds freely in the bilge water of river boats. Shallow, transverse steel girders, projecting a variable distance inwards from the inner surface, divide the hulls into compartments that form ideal pools for *Stegomyia* propagation. In the transomes and chain-lockers these pools are particularly difficult of access.

I inspected one 'stern-wheeler' and two launches, and in all three *Stegomyia* were numerous.

It may here be remarked that cases 6, 21, 35, were employed on river craft. This would necessitate their frequent presence on board at night. Case 31, though employed on ship-board, was probably infected ashore.

VII.—*Movements of Population suggesting possible Transmission of Virus*

There is a considerable traffic affecting Forcados and Burutu—almost entirely by river and sea. As has been stated, ocean-going steamers are able to enter the Forcados River, where an interchange of cargo and passengers may take place with smaller steamers (branch boats) and river-craft of various kinds, all of which go alongside the larger vessel as she lies in mid-stream. Occasionally these ocean-going ships moor at the wharf. Some proceed to Burutu, where they invariably go alongside the wharf.

In addition to these ocean-going ships there is a considerable traffic as follows:—

---

* Mosquitoes have also been found to breed in the numerous tortuous burrows of crabs. These may perhaps be a not inconsiderable source of *Stegomyia*, especially in the dry season, when they are not, as in the wet season, subject to constant flushing. The level of the subsoil water at Forcados to which the burrows may extend is within one or two feet of the surface.

1. By Government craft:
   (*a*) 'Stern-wheeler' on the Niger River—weekly—to and from Northern Nigeria. The journey may occupy many days.
   (*b*) Launch to and from Warri—bi-weekly; journey approximately four hours, often accomplished after sunset.
   (*c*) Launch to and from Sapele—weekly journey approximately ten hours, often accomplished after sunset.
2. By numerous passenger-carrying vessels owned by mercantile firms.
3. By canoe.

It will be evident from consideration of the above facts that the facilities for rapid transit, not only of passengers, but also of *Stegomyiae*, are considerable. The following are some statistics referring to the months of June, July, and August, 1913, illustrating the very large movements of population. They have reference only to craft owned by Government, by Messrs. The Niger Company, and by Messrs. Elder Dempster and Company. There are several other firms owning passenger-carrying vessels. Neither the traffic upon these nor the canoe traffic is included, and the figures do not purport to be, therefore, a complete statistical return of river traffic affecting the ports of Forcados and Burutu.

Statistics Illustrating Movements of Population affecting Forcados and Burutu in June, July and August, 1913.*

From	To	European	Native	Craft
Burutu ...	Up-river ports	33	417	Government
Up-river ports	Burutu	68	700 (approximate)	,,
Forcados ...	Up-river ports	13	180	,,
,, ...	Sapele, Koko, Burutu, Warri ...	28	1,155	,,
Warri	Burutu, Forcados, Koko, Sapele	54	1,883	,,
Sapele	Koko, Forcados, Warri	26	527	,,
Koko	Sapele, Forcados, Warri ...	3	142	,,
Burutu ...	Up-river ports	80	721	Niger Company
Up-river ports	Burutu	30	388	,,
Forcados ...	Lagos	—	392	Elder Dempster & Co.
,, ...	Accra	—	128	,,
,, ...	Cape Coast Castle	—	34	,,
,, ...	Sekondi	—	27	,,
,, ...	Cape Palmas	—	4	,,
,, ...	Sierra Leone	—	45	,,
,, ...	Bonny	—	15	,,
,, ...	Calabar	—	35	,,

* The figures represent the totals for three months

SECTION III

Introduction.—This section deals with thirty-three cases of fever which occurred on ocean-going vessels and dredgers in 1912 and 1913.

Twelve of these cases were definitely diagnosed as yellow fever; the remaining twenty-one were not so diagnosed, but are included here because, while some of them are characterized merely by certain suggestive features, others are undoubtedly highly suspicious.

Reference has already been made to several of these cases in more or less detail in other sections of this report and in my Report No. 1, but it will be convenient to group them all together in this section.

It should be remarked that, in some instances, it has not been possible at the time of my investigation to ascertain the precise movements of the patients and ships under consideration, but that the information, whenever available, has been rendered in detail.

A tabulated statement of the cases, arranged in chronological order, will be found on page 157.

The clinical and epidemiological features of cases 15, 16, 17, 18, 19 (which occurred at Warri) have been fully dealt with in Section I, and will accordingly not be further referred to except in my concluding paragraph. The remaining cases are conveniently divided into two groups (A) and (B).

Group (A) includes cases 1, 2, 3, 4, 5, 9, 10, 11. Their clinical features have been described and discussed in Report No. 1, paragraph VIII (which see), but for convenience of reference are recapitulated here, while their epidemiological characters are also now dealt with. A note regarding quinine treatment, together with temperature charts of each case, inadvertently omitted from Report No. 1, is now included. Cases 1, 2, 3, 5, 9, 10 correspond respectively to cases, 3, 5, 6, 7, 9, 10 in Table 3, paragraph VIII, Report No. 1. All the cases in this group, with the exception of No. 4 (this patient died in Lagos Roads), occurred on ships in the harbour and were treated in Lagos Hospital.

Group (B) includes cases 6, 7, 8, 12, 13, 14, 20 to 33, which have not been dealt with in other sections. Case 12, which occurred in May, should have been included in Report No. 1, paragraph VIII, but was accidentally omitted.

No. of Case in Report	Commission No.	Date	Name of Vessel	Diagnosis	Result	Remarks
1	†	February, 1912	s.s. 'Mayumba' ...	Malarial fever	Recovery	European: Treated in Lagos Hospital
2	†	November, 1912	s.s. 'Lokoja'	Malarial fever	Recovery	European: Treated in Lagos Hospital
3	†	December, 1912	'Sandgrouse,' dredger	Malarial fever	Recovery	European: Treated in Lagos Hospital
4	†	December, 1912	s.s. 'Shonga'	Hyperpyrexia, no doubt due to malarial fever	Death	European: Died on shipboard in Lagos Roads
5	†	December, 1912	—	Malarial fever	Recovery	European: Treated in Lagos Hospital
6	†	January, 1913 ...	s.s. 'Patani'	Malaria and hyperpyrexia ...	Death	European: Died on shipboard at Sapele
7	†	January, 1913 ...	s.s. 'Oshogbo' ...	Hyperpyrexia	Death	European: Died on shipboard at Forcados
8	†	January, 1913 ...	s.s. 'Adansi'	Yellow fever	Death	European: Died on shipboard at Saltpond, Gold Coast
9	†	March, 1913 ...	'Sandgrouse,' dredger	Malarial fever	Recovery	European: Treated in Lagos Hospital
10	†	March, 1913 ...	s.s. 'Lagoon'	Malarial fever	Recovery	European: Treated in Lagos Hospital
11	L.22	May, 1913 ...	s.s. 'Gouverneur von Puttkammer'	Malaria and uraemia	Death	European: Died in Lagos Hospital
12	L.36	May, 1913 ...	s.s. 'Epe'	Yellow fever and malarial fever	Recovery	European: Treated in Lagos Hospital
13	L.46	July, 1913 ...	s.s. 'Delta'	Yellow fever	Recovery	Native: Treated in Lagos Hospital
14	L.53	August, 1913 ...	s.s. 'Ivy'	Yellow fever	Recovery	Native: Treated in Lagos Hospital
15	†	August, 1913 ...	s.s. 'Lulu Bohlen' ...	Fracture of skull	Death	European: Died on shipboard at Koko
16	†	September, 1913	s.s. 'Lulu Bohlen' ...	Malaria and albuminuria ...	Recovery	European: Treated in Warri Hospital
17	L.66	September, 1913	s.s. 'Thomas Holt' ...	Malaria and albuminuria ...	Recovery	European: Treated in Warri Hospital
18	L.67	September, 1913	s.s. 'Thomas Holt' ...	Malaria and albuminuria ...	Recovery	European: Treated in Warri Hospital
19	L.68	September, 1913	s.s. 'Thomas Holt' ...	Malaria and albuminuria ...	Recovery	European: Treated in Warri Hospital
20	L.113	October, 1913 ...	s.s. 'Zaria'	Yellow fever	Death	European: Died on shipboard at Forcados
21	†	October, 1913 ...	s.s. 'Niger'	Cyclical albuminuria	Recovery	Native: Treated in Forcados Hospital
22	?	October, 1913 ...	s.s. 'Effo'	—	Recovery	Native: Treated in Forcados Hospital
23	?	October, 1913 ...	s.s. 'Abonnema' ...	—	Recovery	Native: Treated in Forcados Hospital
24	?	October, 1913 ...	s.s. 'Iddo'	Phthisis	Recovery	Native: Treated in Forcados Hospital
25	†	October, 1913 ...	s.s. 'Elmina'	Hyperpyrexia occurring during an attack of malaria	Death	European: Died on shipboard between Forcados and Lagos
26	L.129	October, 1913 ...	s.s. 'Monrovia' ...	Yellow fever	Recovery	European: Treated in Calabar Hospital
27	L.102	October, 1913 ...	s.s. 'Elizabeth Brock'	Yellow fever	Death	European: Died on shipboard at Lagos
28	L.103	October, 1913 ...	s.s. 'Elizabeth Brock'	Yellow fever	Recovery	European: Treated in Lagos Hospital
29	L.104	October, 1913 ...	s.s. 'Elizabeth Brock'	Yellow fever	Recovery	European: Treated in Lagos Hospital
30	L.105	November, 1913	s.s. 'Bassa'	Yellow fever	Death	European: Died in Lagos Hospital
31	?	December, 1913	—	Malignant malaria	Death	European: Died at Port Harcourt
32	L.107	December, 1913	s.s. 'Montenegro' ...	Yellow fever	Death	European: Died on launch which was conveying him to Lagos Hospital
33	L.119	December, 1913	s.s. 'Nyanga'	Yellow fever	Death	European: Died on shipboard in Lagos Roads

The sign (†) signifies that the notes of the case were not submitted to an Investigator.
The question mark (?) signifies that the Commission number was unobtainable.

Group A

Case I

(i) *Summary of Clinical Features:*—

Age: 28.
Sex: Male.
Race: European.
Occupation: Seaman.
Date of admission to Lagos Hospital: February, 1912.
Diagnosis: Malarial fever.
Result: Recovery.
Number of days in hospital: Five.
Urine: S.G. 1020. Albumen present.
Blood: No record.
Quinine treatment: Five grains hydrochloride four-hourly on first day; subsequently thrice daily.
Remarks: Condition of tongue not noted.

(ii) *Epidemiological Characters:*—

This case occurred on the s.s. 'Mayumba.' The vessel had reached Forcados on the 24th December, 1912, with a cargo of coal from South Wales. She had called at Sierra Leone to embark a native crew. No deck passengers (natives) were carried. She left Forcados for Warri on 6th January, returning to Forcados on the same day and subsequently she proceeded to Lagos, where, in February, the patient was admitted to hospital.

No other cases occurred on this vessel.

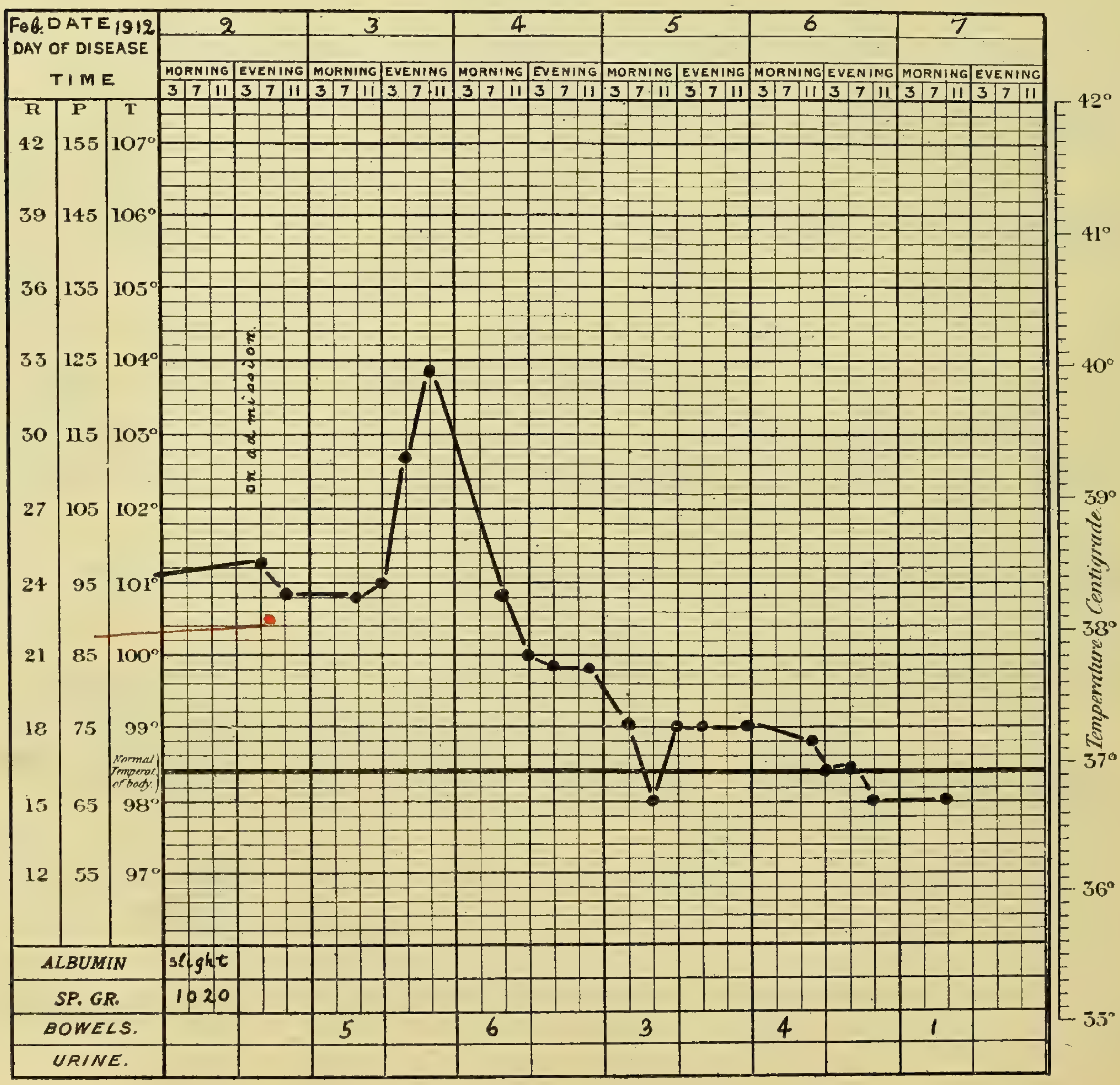

Chart 66

CASE 2

(i) *Summary of Clinical Features:*—

Age: 40.
Sex: Male.
Race: European.
Occupation: Seaman.
Date of admission to Lagos Hospital: November, 1912.
Number of days in hospital: Five.
Diagnosis: Malarial fever.
Result: Recovery.
Urine: S.G. 1025. Albumen present.
Blood: No record.
Quinine treatment: Five grains hydrochloride thrice daily throughout illness.
Remarks: Condition of tongue not noted.

(ii) *Epidemiological Characters:*—

This case occurred on the s.s. 'Lokoja,' a 'branch-boat' plying between Lagos and Forcados (24 hours' journey), and ships lying in Lagos Roads (communication in the Roads is carried on by open boats). The vessel was at Forcados from 26th September to 16th October, 1912, when she left for Lagos. She was again at Forcados from 8th to 9th November. Subsequently she left for Lagos.

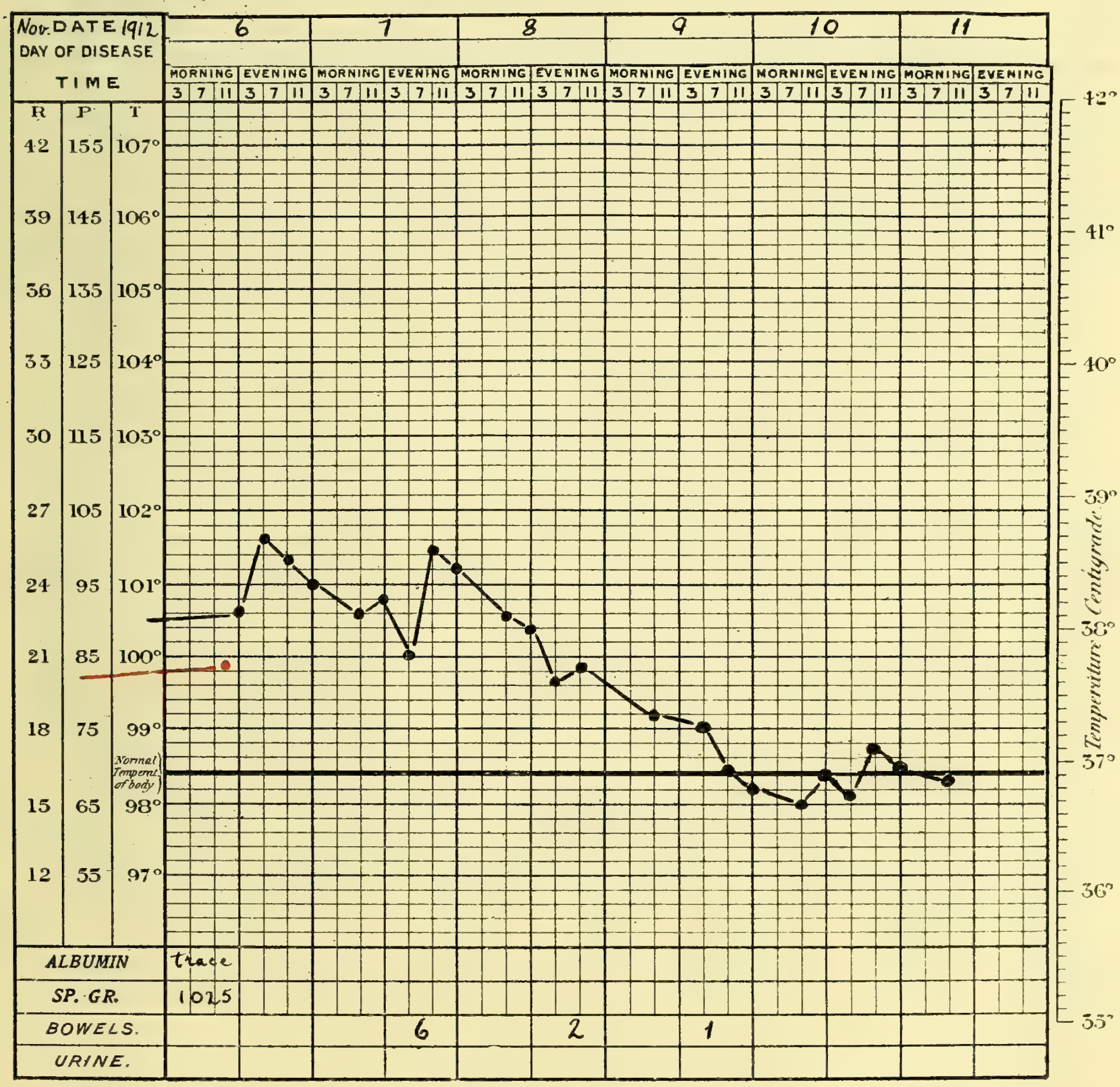

Chart 67

Case 3

(i) *Summary of Clinical Features :—*

Age : 34.
Sex : Male.
Race : European.
Occupation : Seaman.
Diagnosis : Malarial fever.
Date of admission to hospital : December, 1912.
Number of days in hospital : Five.
Result : Recovery.
Urine : S.G. not recorded. Albumen present.
Blood : No record.
Quinine treatment : Five grains hydrochloride thrice daily throughout illness.
Remarks : Condition of tongue not noted.

(ii) *Epidemiological Characters :—*

This case occurred on the dredger 'Sandgrouse,' engaged on the harbour works at Lagos. The vessel had not been out of Lagos Harbour for six months.

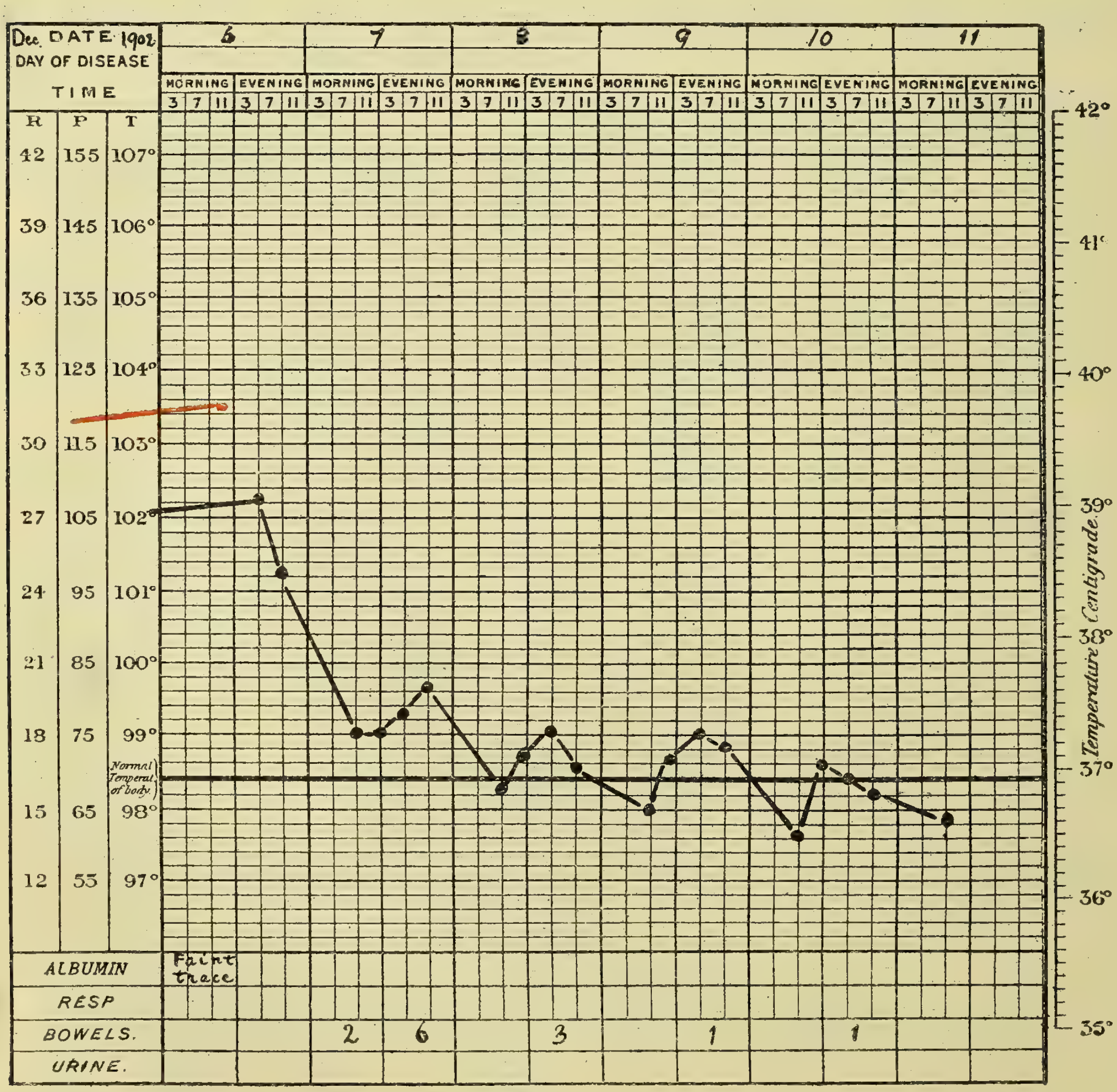

Chart 68

Case 4

(i) This patient died on board the s.s. 'Shonga,' in Lagos Roads, on 2nd December, 1912.

The following is a copy of the notes of the post-mortem examination, which was performed by the Resident Medical Officer, Lagos Hospital :—

Age : 34.

Death occurred at 5 p.m. on board s.s. 'Shonga,' in Lagos Roads—December 2nd, 1912.

Post-mortem examination held at 1 p.m., December 3rd, 1912, in hospital mortuary, 20 hours after death.

External appearances : Body well nourished. Rigor mortis passing off. Putrefaction had commenced. Bullae on skin. Post-mortem lividity in dependent parts.

Abdomen : Liver, somewhat enlarged, soft, and congested. Stomach, thinning of walls at greater curvature. Mucosa congested. Stomach contents, dark coloured fluid. Spleen, enlarged and soft, almost diffluent.

Temperature of body at time of death was 110° Fahr.

Sections of spleen and liver taken and sent to Medical Research Institute for examination.*

Death certified as due to hyperpyrexia, 'No doubt due to malarial fever.'

The 'Shonga' did not carry a doctor.

(ii) *Epidemiological Features* :—

The vessel had been in Southern Nigeria waters for one month, and had, while at Forcados, given her cargo to the branch-boat 'Baro,' which was moored alongside. She had also called at several other ports in Nigeria (but not at Sapele—reference cases 6 and 8), from none of which had suspicious cases been reported. At a Liberian port she had embarked a native crew. No cases of the disease had been reported from Liberia. She carried no deck passengers.

Case 5

(i) *Clinical Features* :—

(As in paragraph viii, Report No. 1, this case is cited in detail because it appears to present some specially significant features.)

Age : ?

Sex : Male.

Race : European.

Occupation : Seaman.

Diagnosis : Malarial fever.

Admitted to hospital : December, 1912. First trip to the West Coast of Africa. Has been out one month. Does not take quinine. There is no record respecting the onset of the illness.

On admission : Headache complained of. Urine, a thick cloud of albumen. Temperature, 103·6°. Pulse, 104.

Second day : Maximum temperature, 104°. Pulse, not recorded. Headache continues. Urine, 19 ounces.

---

* There is no record to be found.—E. J. W.

Third day: Maximum temperature, 102·9°. Pulse, 88. Urine, 17 ounces, albumen in large amount. Face flushed. Eyes red. Conjunctivae yellowish. Vomited once after quinine; no blood in the vomit. Patient says he feels worse, but is, apparently, better.

Fourth day: Maximum temperature, 101·6°. Pulse, 72.

Fifth day: Maximum temperature, 100·4°. Pulse not recorded. Albumen gone. No jaundice.

Sixth, seventh, eighth, ninth day: Uneventful recovery.

Blood: No parasites found.

Quinine treatment: Five grains* three times a day throughout the illness.

There are no notes respecting the state of the tongue.

(ii) *Epidemiological Characters:*—

Unfortunately the name of the vessel upon which this case occurred is unknown.

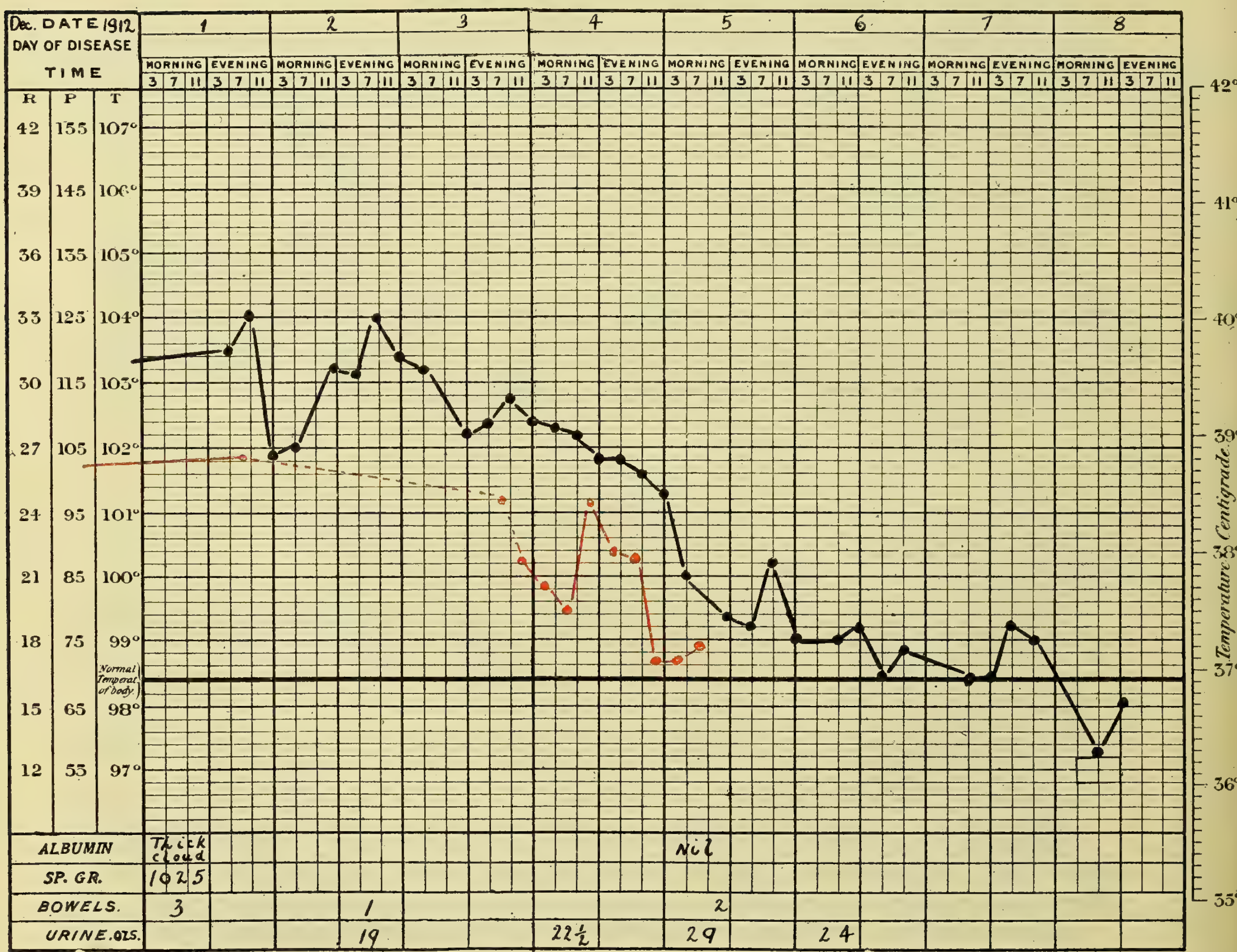

Chart 69

* Probably hydrochloride.—E. J. W.

CASE 9

(i) *Summary of Clinical Features:—*

Age: 33.
Sex: Male.
Race: European.
Occupation: Seaman.
Diagnosis: Malarial fever.
Date of admission to Lagos Hospital: March, 1913.
Number of days in hospital: Six.
Urine: Albumen present. S.G. 1025.
Blood: No record.
Quinine treatment.—Five grains hydrochloride morning and night throughout illness.
Result.—Recovery.
Remarks.—Tongue coated on admission.

(ii) *Epidemiological Characters:—*

This case occurred on the dredger 'Sandgrouse,' engaged on the harbour works at Lagos. The 'Sandgrouse' had not been out of Lagos Harbour for six months.

It will be remembered that Case 3 occurred on this vessel—but in December, 1912.

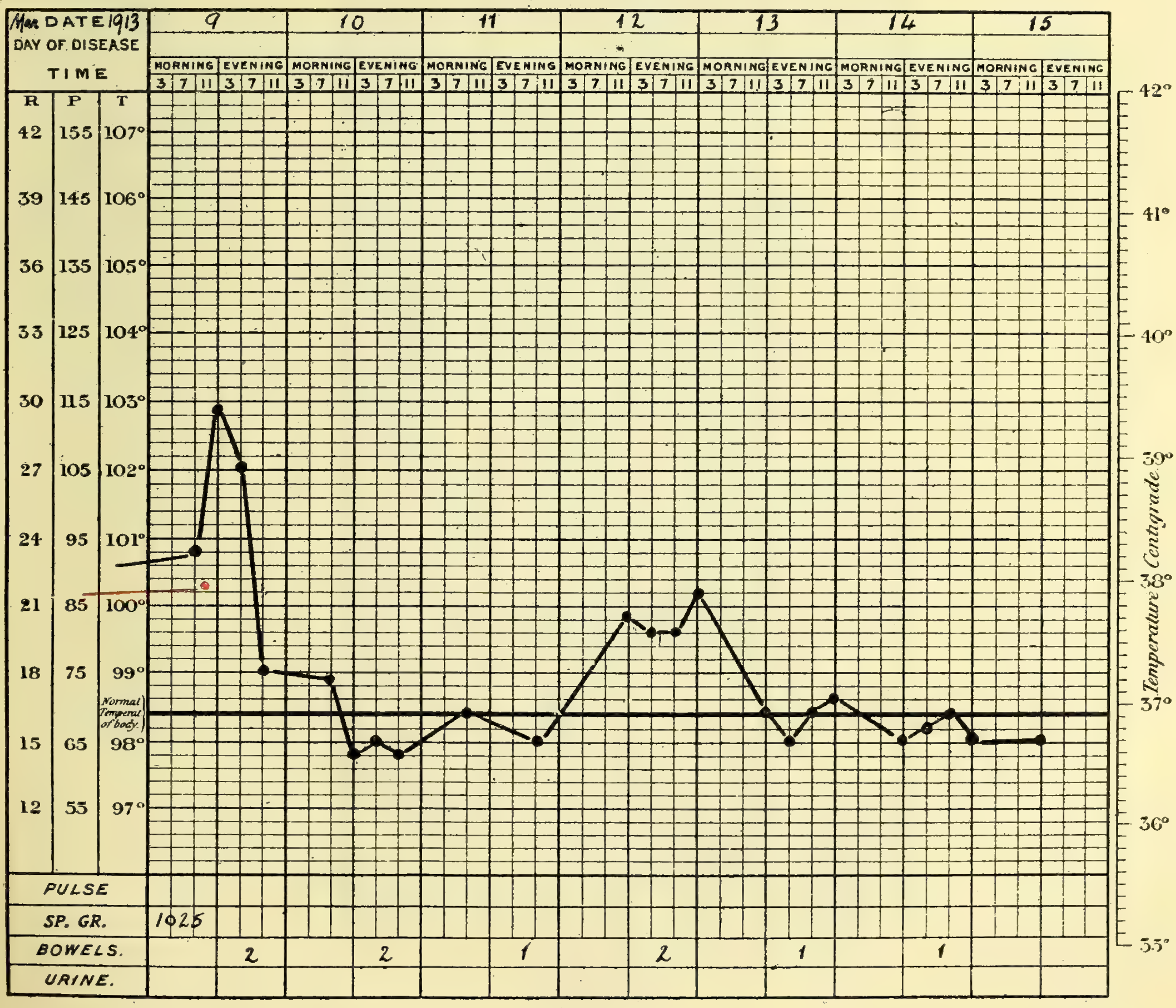

Chart 70

Case 10

(i) *Summary of Clinical Features:—*

Age: 41.
Sex: Male.
Race: European.
Occupation: Seaman.
Diagnosis: Malarial fever.
Date of admission to Lagos Hospital: March, 1913.
Number of days in hospital: Two.
Urine: Albumen present. S.G. 1019.
Blood: No record.

Quinine treatment.—Five grains hydrochloride morning and night throughout illness.

Result.—Recovery.

Remarks.—Tongue coated on admission.

(ii) *Epidemiological Characters:—*

This case occurred on the s.s. 'Lagoon,' a branch-boat plying between Lagos and Forcados and ships lying in Lagos Roads. She had been at Forcados from 20th February to 7th March, when she left for Lagos.

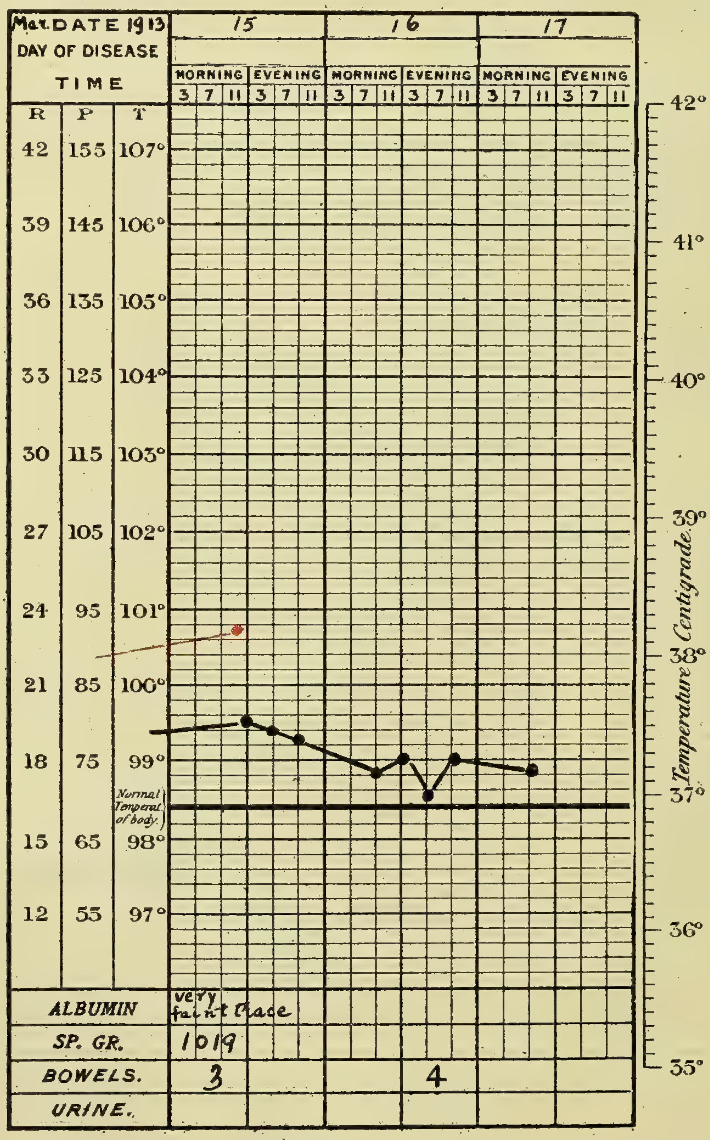

Chart 71

CASE II. L. 22†

(i) *Clinical Features:—*

This case, as in paragraph VIII, Report No. 1, is cited in detail because it presents many points of interest. It was decided not to be a case of yellow fever, after very careful deliberation.

Age: 28.
Sex: Male.
Race: European.
Occupation: Engineer on s.s. 'Gouverneur von Puttkammer.'
Nationality: German.
Date of admission to hospital: 8th May, 1913.
Date of death: 9th May, 1913.
Diagnosis: Uraemia and malaria.

History.—Patient had been ill three days with fever. Vomited after taking any drink. Bowels had been confined, but were opened by an aperient. No headache.

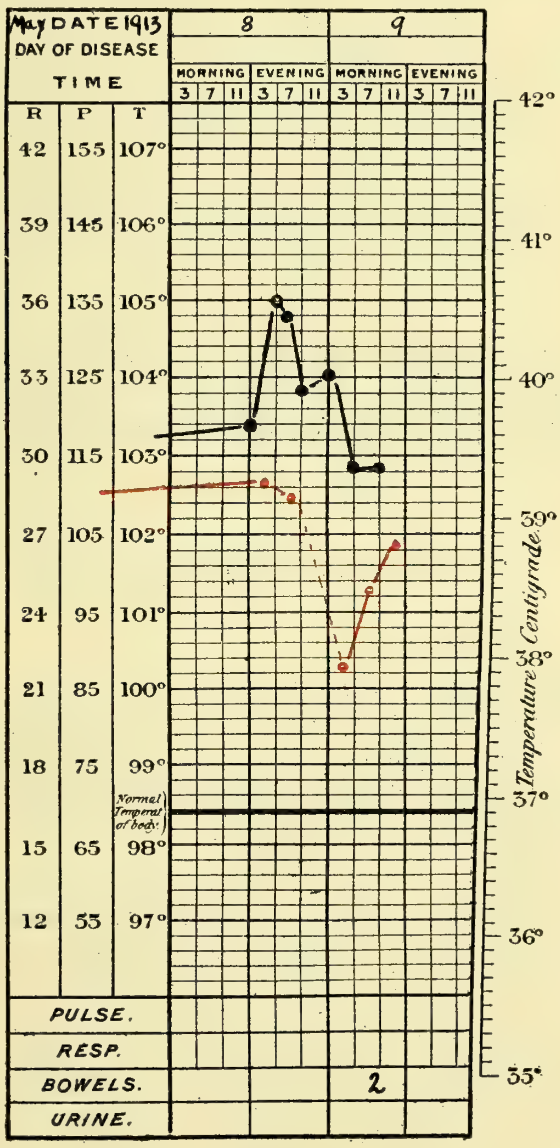

Chart 72

On admission.—Tongue coated. Bowels opened. Liver and spleen normal. No tenderness in epigastrium. Pulse, 112. Heart sounds normal. Respirations, 24. Temperature, 103·4° Fahr. Severe headache. Pupils widely dilated. Face puffy. Slight oedema over both legs. Urine, acid, S.G. 1030, albumen large quantity. Blood, young ring parasites, aestivo-autumnal. Mononuclear leucocytosis.

Course.—12 p.m. on day of admission: Temperature, 104°; vomited once; urine contains albumen, amount passed at 8.45 p.m., four ounces. 9th May, 1913: Patient very restless and delirious; no sleep; no urine passed; bowels opened, watery motions; vomiting very frequent, dark, acid-smelling liquid; saline given intracellularly—250 c.c. 1.30 p.m.: Pilocarpine, grains $\frac{1}{4}$, given; pupils widely dilated; delirium present. 2 p.m.: Uraemic convulsions began; vomiting very troublesome, dark, acid-smelling liquid. 3.20 p.m.: Died.

Pulse and temperature were as follows:—

	8th May				9th May	
	12 noon	4 p.m.	8 p.m.	12 midnight	4 a.m.	8 a.m.
Temperature	104	104·8	103·8	104	102·8	102·8
Pulse	112	100	—	88	98	104

Quinine treatment.—Two intramuscular injections of quinine on the day of admission (0·4 grams).

Note.—The patient is said on good authority to have been a chronic alcoholic subject.

Post-mortem Notes

Rigor mortis had not set in.

Body was extremely fat and well-nourished.

There was no yellow staining of the skin or conjunctivae.

Thorax.—Heart: Pericardium normal, contained some fluid; heart flabby and large deposit of fat around it, otherwise normal. Lungs: No pleural adhesions; no effusion; congested, particularly at bases.

Abdomen.—Liver: Pale in colour; on section was fatty, the cut surface being greasy. Stomach: Pale in colour; no external haemorrhages; contained a small quantity of brown fluid, with a urinous odour; the mucous membrane was not congested; no haemorrhages. Intestines: Normal in appearance; no external haemorrhages; there was no congestion of the mucous membrane; a brown faecal fluid was present in small amount. Kidneys: Both kidneys were enlarged and congested; the capsule stripped easily; no external haemorrhages were to be seen. On section the cortex appeared swollen and pale. The omentum was extremely fatty and there was a large deposit of fat about the abdomen.

Extract of Report upon Pathological Specimens sent to Research Institute, Yaba

The organs were unfortunately somewhat damaged by being forced into a jar with insufficient preserving fluid; in consequence it is difficult to determine to what extent the appearance of sections is due to this cause, and to what extent to pathological changes. . . .

The kidney was enlarged, its capsule adherent and its surface injected with stellate veins. The cortex was swollen and yellowish, the pyramids not markedly congested. The tubules distended, the epithelium granular. The tubules contained casts. Glomeruli large, capsule thickened. Interstitial tissue somewhat increased.

The liver (small piece) was yellow in section, surface smooth. Extensive and intense fatty degeneration.

The spleen was large and pulpy. The capsule thickened, congested, and dotted with masses of yellowish pigment. (The spleen, however, was certainly insufficiently preserved, as it had putrefied.)

The stomach.—Several minute haemorrhages. Mucosa, catarrhal.

The appearances were hardly those one would expect to meet in a case of acute nephritis, and, on the whole, were more suggestive of an acute fever.

I suppose there was no suspicion of yellow fever?

J. W. Scott Macfie.

(ii) *Epidemiological Characters:*—

The vessel from which this case was admitted while she was lying alongside the wharf at Lagos—the 'Gouverneur von Puttkammer'—had sailed from Hamburg on 19th January. The patient sailed with her.

The only intermediate port of call was in Liberia, to embark a native crew.

She carried no deck passengers.

After her arrival in Lagos, the vessel plied solely between Lagos and Forcados and ships lying in Lagos Roads. There had been no sickness on board prior to the patient's illness, and subsequently, also, there was none except the case of a man who was admitted to Lagos Hospital suffering from a typical attack of malarial fever on 21st May and discharged on 2nd June.

The patient was frequently ashore, both at Lagos and Forcados.

General Remarks

It is not possible in any of the above cases (Group A) definitely to trace the source of infection. As far as I have been able to ascertain no other cases presenting anomalous characters occurred on any of the vessels from which they were taken. Messrs. Elder Dempster & Company's Medical Officer, at Forcados, who kindly gave me access to his records, attends all cases of sickness occurring on his Company's ships at that port, unless a ship's medical officer is carried. Elsewhere—with the same exception—cases are attended by Government Medical Officers and are carefully recorded.

None of the ships on which cases in Group A occurred carried a doctor.

Cases 1, 2, 3, 4, and 5 occurred at a time (1912) when no suspicious cases had been reported. At the time when Case 9 occurred no suspicious cases had been reported from Lagos, where the vessel was engaged in dredging, though cases in natives were then occurring at Burutu.

In Cases 10 and 11 the patients may have become infected at Forcados—Burutu being the actual source of infection. As has been mentioned elsewhere, the traffic between Burutu and Forcados is considerable.

It has, however, to be remembered that the 'Mayumba,' the 'Shonga,' and the 'Gouverneur von Puttkammer' (Nos. 1, 4, and 11 respectively) had embarked a native crew on reaching the West Coast of Africa, and may in this way have become infected, though none of these vessels had called at Dakar, the only port on the West Coast which was declared to be infected with yellow fever in the last six months of 1912. It should here be remarked that the case on the 'Gouverneur von Puttkammer' occurred several days *before* the first case of the disease was reported at Lagos, which had come from Abeokuta, and was almost certainly infected there (Report No. 1).

If these cases in Group A were actually yellow fever it is necessary (excluding a possible animal source) to invoke the endemicity of the disease among the natives in order to explain the infection. For it is not to be supposed that these various branch-boats, dredgers, etc., could have been themselves infected and conveyed the disease to one another and yet that only sporadic cases should have occurred. On none of the vessels mentioned were there less than three or four Europeans whose quarters would be closely associated. I conclude that the patients must almost certainly have become infected ashore.

Moreover, the vessels on which Cases 2, 3, 9, and 10 occurred had not been out of Southern Nigeria waters for many months before the patients were taken ill, and the vessels on which Cases 1, 4, and 11 occurred had been in Southern Nigeria waters for at least one month before the patients were taken ill, and, previously, had come direct from Europe, only stopping on first reaching the West

Coast of Africa to embark a native crew. The possibilities of infection from this source have already been discussed (see Cases 3, 4, 5, Section I, paragraph vii).

Group B

Case 6

This patient died at Sapele (Niger Delta), on board the s.s. 'Patani,' a cargo-boat, plying between Liverpool and the West Coast of Africa, on the 10th January, 1913. No post-mortem examination was performed.

The following is a copy of the notes of the case by the then Medical Officer, Sapele :—

> 'I was called to see the patient on the s.s. 'Patani,' on January 10th, 1913. Arrived there about noon. Found him unconscious. Temperature 108·4°. Pulse running. He died at 4.40 p.m. There were no signs of yellow fever. No urine was passed during the time I attended him. Death, in my opinion, was due to a hyperpyrexial attack of malaria, in a non-quinine taker and debilitated subject.
>
> 'Previous habits.—This was his first voyage to West Africa, but he had made one to East Africa. From what I could gather, he was addicted to the drug habit. The night before he died, he was seen to take a sixty minim measure full of chlorodyne. Five minutes afterwards he fell down as if in a fit, frothing at the mouth. He was put to bed, and appeared at breakfast next morning, to all appearances quite normal, and ate a good breakfast—the first for many days (this is the statement made by a steward).
>
> 'About 10 a.m. he appeared to be raving, so they sent ashore for the Medical Officer. I was away in the town and did not see him until noon.
>
> 'I attended one other case on board the 'Patani' : a deck hand suffering from a slight attack of malaria. During the time the s.s. 'Adansi' was here (three days) no illness was reported to me.'

It is not known whether the patient was a quinine taker or used a mosquito net.

The Medical Officer, who attended the case, and whom I met later in the course of my inquiry, further informed me that :—

> The patient was an alcoholic subject, and was also addicted to the use of morphia.
>
> When first seen, at noon on the day of his death, the temperature was 108·4°.
>
> At one o'clock he was given an intramuscular injection of bihydrochloride of quinine—10 grains—and was placed in an ice bath. The temperature dropped to 104·5°. There was then commencing cardiac failure. A second ice bath was given one hour later, when the temperature had risen again to 106°. After one hour's immersion this was reduced to 104°.
>
> Except when first seen, the patient was unconscious. There was no jaundice, rash, or discolouration evident after death.
>
> According to the captain of the vessel there had been no sickness on board previously.

The ship had been in Southern Nigeria waters from January 3rd (seven days). The following had been her itinerary : Liverpool, Madeira, Teneriffe, Grand Canary, Conakry, Sierra Leone, Cape Palmas, Lahou, Half Jack, Grand Bassam, Assinee, Axim, Sekondi, Cape Coast, Saltpond, Accra, Kotonou, Brass, Akassa, Forcados.

On arrival off the West Coast of Africa she, as usual, embarked a native crew. She carried no deck passengers.

She arrived at Forcados on 3rd January and her course was then as follows :—

Arrived Forcados	3rd January.
Left Forcados	4th January.
Arrived Warri	4th January.
Left Warri	6th January.
Arrived Koko	7th January.
Left Koko	8th January.
Arrived Sapele	8th January.
Left Sapele	11th January.
Arrived Koko	11th January.
Left Koko	15th January.
Arrived Forcados	15th January.
Cleared for home	17th January.

Whilst at Forcados, on 3rd January, the branch-boat 'Bassa' was moored alongside and took her cargo.

It should be remarked : (*i*) That Messrs. Elder Dempster & Company's Medical Officer at Forcados was called to see an Engineer on the 'Patani' upon her return to Forcados from Sapele. He had suffered from (?) 'bad fever' at Sapele, but was convalescent when seen at Forcados. (*ii*) That the 'Patani' was at Koko and Sapele, on the 7th and 8th of January, simultaneously with the s.s. 'Adansi,' on which ship a death from yellow fever subsequently occurred at Saltpond (Gold Coast), on the 18th January. It is very probable that interchange of visits between members of the ships' crews took place on these occasions, and that such visits would most probably have been paid after sunset. Also the respective anchorages of the ships would be in a moderately close proximity. Thus infection may readily have been conveyed from one vessel to the other, and it will be noted that the death on the 'Adansi' took place at Saltpond ten days after they had been together. It is, however, improbable that—assuming the 'Patani' case to have been yellow fever—the infection was obtained from the 'Adansi,' for the two ships were first together on the 7th January and the patient died on the 10th. It would on the contrary, be more probable that the 'Adansi' patient was infected from the 'Patani,' the patient on the 'Adansi' having died on the 18th January—ten days after the ships were together (see Case 8).

On the assumption of the endemicity of the disease in the Colony, the patient (Case 6) on the 'Patani' was probably infected from a native source at, *e.g.*, Forcados, where the ship stayed from 3rd to 4th January, *i.e.*, six days before his decease. He may have become infected ashore, or infected mosquitoes may have gained access to the ship from the branch-boat 'Bassa' (no cases of sickness had, however, occurred on the 'Bassa').

That there were infected mosquitoes on board the 'Patani' seems improbable, since, with the one exception, no cases of illness occurred on board, and one is, therefore, led to the conclusion that the patient was infected from the native source.

Case 7

This occurred on the s.s. 'Oshogbo,' a branch-boat plying between Lagos and Forcados.

The patient died on the vessel at Forcados, on 12th January. He was attended by Messrs. Elder Dempster & Company's Medical Officer at that port.

His notes of the case are as follows :—

> 'On the evening of the 11th inst. the deceased had a temperature of 103° Fahr.; much vomiting. Ten grains of quinine were administered with some juice afterwards. On the following morning he was worse, temperature 111° Fahr. He died in my presence. There was nothing special in the case except the high temperature.'

Quinine prophylaxis and use of mosquito net—unknown.

No autopsy was made.

The itinerary of this vessel had been as follows :—

Arrived Forcados from Lagos, 11th December.
Left Forcados for Lagos, 21st December.
At Lagos from 22nd December to 7th January.
Arrived Forcados from Lagos, 8th January.
Left Forcados for Lagos, 17th January.
At Lagos from 18th January to 31st January.

No other cases occurred on this vessel, which did not carry a doctor.

She had been in Southern Nigeria waters for many months. She had not been at Sapele (ref. Cases 6 and 8).

The patient may have become infected at Forcados—Burutu being the actual source of infection (see Section II). As already stated, the traffic between Burutu and Forcados is considerable.

Case 8

This occurred on the s.s. 'Adansi,' a cargo-boat plying between Hamburg and the West Coast of Africa. A European seaman died on board of yellow fever at Saltpond (Gold Coast) on 18th January, 1913. The ship did not carry a Medical Officer and there are thus no notes of the patient's illness. He was found wandering about the deck (which was contrary to orders) at 3 a.m. on the 16th January, and died on the morning of the 18th at 1 a.m. The captain had treated him with phenacetin and quinine, milk diet and Benger's food.

Quinine prophylaxis and use of mosquito net—unknown.

The following is a copy of the notes of the autopsy made by the Government Medical Officer at Saltpond :—

Notes on Post-mortem made at 8.45 *a.m. on board the s.s. 'Adansi.'*

External.—The body of a well-nourished adult male, aged about 35 years. No marks of violence.

1. Rigor mortis well marked.
2. The whole surface of the body presented an intensely jaundiced appearance.
3. Petechiae over the side of the neck and chest, and extravasations of blood all over the back.
4. Hands, feet, and genitals cyanosed.
5. Rectal temperature 104° Fahr.
6. Liver normal in size and of an intense yellow colour.
7. A brownish grumous looking fluid was welling out of the mouth.
8. Stomach—intensely hyperaemic, especially towards the cardiac end.
9. Stomach contained about half-a-pint of black tarry fluid.
10. Heart, normal in size, somewhat flabby.

N.B.—The body was sewn up in canvas, weighted with iron, and taken two miles out to sea and buried.

The itinerary of the vessel had been as follows:—Hamburg, Rotterdam, Teneriffe, Las Palmas, Sierra Leone, Axim, Sekondi, Cape Coast, Saltpond, Appam, Winneba, Accra, Addah, Burutu, Warri, Koko, Sapele, Forcados, Addah, Accra, Winneba, Appam, Saltpond.

The vessel had been in Southern Nigeria waters from 21st December to 12th January, when she left Forcados for the Gold Coast. She had been at Koko and Sapele on the 7th and 8th January simultaneously with the s.s. 'Patani,' on which a death of a doubtful nature occurred on 10th January. (See Case 6.)

On the 12th January—the day before clearing for the Gold Coast—the vessel was visited at Forcados by Messrs. Elder Dempster & Company's Medical Officer. There was then, as he informed me, no sickness on board.

Therefore, allowing a maximum incubation period of six days, the patient must have become infected on or after the 7th January. Hence the locality of his infection must have been either:—

1. The Gold Coast, or
2. Southern Nigeria, either:—
   (i) On board the 'Patani' at Koko or Sapele,
   (ii) on board the 'Adansi,' or
   (iii) ashore at Koko, Sapele or Forcados.

1. Possibility of patient's infection on the Gold Coast.

Between Forcados and Saltpond the vessel called at Addah on 13th January, at Accra on 15th January, at Winneba on 16th January, and at Appam on 17th January.

If the patient became infected *on the ship* while she was at any of these ports between Forcados and Saltpond, he must have become so by a mosquito which had received its infection at least twelve days previously; *i.e.*, the insect must have been brought aboard at these ports in an infective condition. This is unlikely, as ships lie in the Roads, a considerable distance (1-2 miles) from the shore and traffic is carried on by open surf boats. Again, the patient may have gone ashore at these ports at night—an improbable contingency, I am informed—and there become infected. In either case, the number of days between the dates of call and his death: five, three, two, and one, respectively, in the case of Addah, Accra, Winneba and Appam would, with the exception perhaps of Addah, connote a remarkably short incubation period and course. I do not emphasize the fact that no cases of yellow fever had been reported from these ports, since, assuming the endemicity of the disease, this ceases to be an important consideration.

From the above facts it is therefore to be inferred that he did not become infected on the Gold Coast.

2. Possibility of patient's infection in Southern Nigeria.

(i) On board the 'Patani' at Koko or Sapele.

This is rendered improbable by the fact that no suspicious cases other than Case 6 occurred on this vessel.

(ii) On board the 'Adansi.'

This is also rendered improbable for the same reason—that no other cases of the disease occurred on the ship either while she was in Southern Nigeria waters or subsequently as far as can be ascertained.

(iii) Ashore at Koko, Sapele, or Forcados.

It having been conceded that infection as described in the above paragraphs is improbable, the patient must almost certainly have contracted the disease ashore at Koko, Sapele, or Forcados, the only places at which he would have

been able to leave the ship. As no suspicious European cases had been reported from any of these places, he must have acquired the illness from a native source.

It follows from this conclusion that the simultaneous presence of the 'Adansi' and 'Patani' at Koko and Sapele on the 7th and 8th January was a coincidence, and that there was no causal connection between this and the 'Patani' case. In order to elucidate the matter as much as possible, and with a view to ascertaining whether any cases had occurred at Sapele or Koko which could be regarded as suspicious, I visited Sapele, the Medical Officer of which district also has Koko under his care, Europeans at the latter place when sick being brought to Sapele Hospital.

I examined all the records of both European and native cases and autopsies from January, 1911, onwards, but found no suspicious cases among them.

Two cases of blackwater fever occurred in 1911, one in 1912, and none in 1913 up to the time of my inquiry (October). I carefully examined the notes of these cases, and found that, as in instances of this disease occurring elsewhere, which I have recorded, there is no reason whatever to suppose that any confusion has occurred between it and yellow fever.

(I found that two cases diagnosed as typhoid fever have occurred at Sapele—one in 1906 and the other in 1913. As this disease forms one of the subjects of inquiry of the Yellow Fever Commission, I have included an account of these with charts in the present Report (Appendix II).) It having been reported that the 'Adansi' patient (Case 8) had been treated for malaria eight days before his death at Benin City, 30 miles from Sapele, whither he would have proceeded overland (probably as an excursion), I proceeded to that town, but was unable to discover any record of the case. I took the opportunity of examining all records from 1911 onwards, but found no cases which could be regarded as suspicious. There was a a case of blackwater fever in 1911 (notes not available) and one in 1912, regarding the accuracy of diagnosis of which there can be no doubt.

Stegomyia fasciata is present at Benin City and at Sapele.

While at Sapele I was informed that a European trader had died in March, 1912, at Silooko, which is situated in the Benin District on one of the creeks of the Niger Delta, and is on the Sapele-Lagos mail-launch route. The Medical Officer at Benin had been unable to reach Silooko until four days after the patient's death.

The agent of one of the trading firms at Sapele saw the patient throughout his illness, and gave me the information which I append :—

> Patient was aged about 30. A strong, athletic man ; a trader. Had been in West Africa about 18 months ; first tour. Had never been in West Indies or America. 'Felt out of sorts' one afternoon. In the evening his temperature was 101°. Next day it fluctuated between 101° and 102°. On the following day (the third of the illness) he died at 4 p.m., his temperature then being 108·5° Fahr. Blood exuded from the mouth at the time of his death. The patient did not 'have a convulsion.' There was no vomiting throughout the illness and the patient had not complained of headache or pain of any kind. On each of the three days of the illness he took 15 or 20 grains of quinine.
>
> The agent further informed me that the deceased was a temperate man though not a total abstainer. He had taken quinine regularly every day until within a week of his illness, when he had ceased taking both alcohol and quinine because he was then suffering from 'a bad attack of boils,' and thought such abstinence might be beneficial. This is the only European who

has died at Silooko within recent years (there are approximately ten Europeans resident—all traders). There was no exceptional illness among the Europeans or natives at the time of the patient's illness.

The agent also informed me that *Stegomyia fasciata*, which he recognizes as the 'football-jersey mosquito,' was present 'in small numbers' in Silooko.

It is certainly much to be regretted that no professional notes of this case are available.

CASE 12. L. 36†

This case occurred on the s.s. 'Epe,' plying between Lagos and Porto Novo. The patient—one of the engineers—was admitted to Lagos Hospital on the 28th May, 1913.

For clinical notes of this case see Dr. Leonard's Report, Case No. 6, page 229.

The patient had been in West Africa only three months. He had previously made voyages to 'the Coast,' but this was the first time he had remained in the country. He was a non-quinine taker, and it is doubtful whether he used a mosquito net.

The s.s. 'Epe' (plying between Lagos and Porto Novo), from which he was admitted to hospital, had left Porto Novo (Dahomey) for Lagos (duration of voyage about nine hours) on the 23rd May, the day before the illness commenced. She had been at Porto Novo three days and was anchored near the shore. The patient had not left the vessel. She carried about 40 native passengers. Her crew consisted of approximately 20 natives and four Europeans.

In the absence of any other cases of illness on board, it is to be supposed that the patient was not infected on the ship, but that he received his infection in Lagos previous to embarkation. It has, however, to be noted that, Lagos not being at the time in quarantine, the crew and passengers were not kept under observation.

CASE 13. L. 46†

This patient, a Krooboy, was a cook on the s.s. 'Delta,' plying between Lagos and Forcados.

For clinical notes of this case see Dr. Leonard's Report, Case No. 16, page 253.

The course of the s.s. 'Delta' previous to the occurrence of this case was as follows:—

Left Forcados	19th June.
Arrived Lagos	20th June.
Left Lagos	15th July.
Arrived Forcados	16th July.
Left Forcados	21st July.
Arrived Lagos	22nd July.

The patient was admitted to Lagos Hospital on the 28th July.

From the 22nd to the 28th July the vessel lay alongside the wharf during the day-time, but at night she was anchored in the Lagoon at a considerable distance from the shore.

Cases of yellow fever were occurring at Lagos at this time.

The patient was a non-quinine taker and did not use a mosquito net.

CASE 14. L. 53†

This patient, a 'Krooboy,' was a quartermaster on the s.y. 'Ivy.'

He was almost certainly infected ashore.

The case is, however, included here among 'ship' cases for the sake of completeness.

For clinical notes of this case see Dr. Leonard's Report, Case No. 20, page 259.

The 'Ivy' had arrived at Lagos from Bonny on 1st July. She remained in Lagos Harbour until August 17th, when she proceeded to Forcados, and was there fumigated. The patient, it will be remembered, was admitted to hospital on 16th August.

During the period 1st July to 16th August, the patient had stayed on shore practically every night. No cases had been reported in the vicinity of his place of residence.

An infected area was declared and no further cases occurred. *Stegomyia fasciata* was found within the area.

No cases occurred on the 'Ivy,' the crew of which numbered six Europeans and forty-seven natives.

Cases 15, 16, 17, 18, 19

For the account of these cases see Section I, paragraph VII.

Cases 16, 17, 18, 19 correspond respectively to Cases 6, 3, 4, 5 in that section. Case 15 is described with Case 6 in that section.

Case 20. L. 113

This patient, an officer of the s.s. 'Zaria,' sailing between Liverpool and the West Coast of Africa, died on board at Forcados, on the 18th October.

Unfortunately, the details of the illness, which the ship's surgeon was able to supply to the Medical Officer, Forcados, are meagre.

For notes of this case see Dr. Leonard's Report, Case No. 36, page 286.

Prophylactic use of quinine and mosquito net—unknown.

Others sick on board—one lady and one man down with fever. Urine said to have contained albumen, but ship's doctor himself very 'seedy' and not fit for work at the time. The man had bled from the nose. Both cases sent to Warri Hospital.*

The following were the movements of the 'Zaria' from the time of leaving England :—

Liverpool		...	16th August.
Teneriffe		...	22nd August.
Las Palmas		...	23rd August.
Dakar (harbour)		...	27th August.
Bathurst (river)		...	28th August.
Sierra Leone (harbour)		...	31st August.
Monrovia (Roads 1—2 miles from shore)		...	4th September.
Grand Bassam	,, ,,	...	5th September.
Cape Palmas	,, ,,	...	6th September.
Half Assinee	,, ,,	...	8th September.
Axim	,, ,,	...	9th September.
Sekondi	,, ,,	...	10th September.
Cape Coast	,, ,,	...	13th September.
Winneba	,, ,,	...	13th September.
Adda	,, ,,	...	15th September.
Accra	,, ,,	...	16th September.
Addah	,, ,,	...	18th September

* There was no evidence of yellow fever in either of these cases whilst in Warri Hospital. They were kept under observation for some days, and then discharged.—E.J.W.

Forcados (alongside wharf)	... ...	23rd-26th September.
Bonny	(river)	27th September.
Okrika	,, ...	28th September.
Bakana	,, ...	29th September.
Buguma	,, ...	29th-30th September.
Abonnema	,, ...	30th Sept.—2nd Oct.
Bonny	,, ...	2nd October.
Opobo	,, ...	3rd-10th October.
Bonny	,, ...	10th-11th October.
Abonnema	,, ...	11th-12th October.
Buguma	,, ...	12th October.
Bakana	,, ...	12th-13th October.
Bonny	,, ...	13th October.
Okrika	,, ...	14th-15th October.
Bonny	,, ...	15th October.
Forcados (anchored in the river on this occasion)		16th-25th October.

On reaching the African Coast the vessel, as usual, embarked a native crew.

From the time of leaving Opobo (10th October), she carried deck (native) passengers.

The captain informed me (i) that, to his knowledge, the patient did not go ashore within a fortnight of his illness, but that he may have done so : (ii) that he used a mosquito net : (iii) that the ship was infested with mosquitoes, especially at Bakana and Okrika, at which places the inconvenience they cause is so great that the vessel does not remain overnight unless absolutely necessary. On this voyage she remained overnight at both places (*i.e.*, within six days of the patient's death).

With the exception of Forcados, where cases in natives were occurring at this time, no suspicious cases had been reported from any of the places in the above itinerary, and none were reported subsequently to the 'Zaria's' visit. No further cases occurred on the ship. The patient must, therefore, almost certainly have become infected from a native source.

It has, however, to be noted that three cases of yellow fever occurred on the s.s. 'Elizabeth Brock'—Nos. 27, 28, 29, on the 26th October. The 'Zaria' and the 'Elizabeth Brock' were at Opobo together on the 6th October, and, on that date, a European passenger was transferred from the latter to the former.

By the courtesy of Messrs. Woermann's Agent at Lagos, I was able to ascertain that the vessels had been anchored about 700 yards apart, and that the 'Elizabeth Brock' had been anchored about 150 yards from the shore. The passengers were conveyed by an open steam launch (no cabin) from one vessel to the other.

The interval between the date at which the vessels were at Opobo simultaneously and the first development of symptoms of illness was respectively as follows :—

'Zaria'	3-7 days.
'Elizabeth Brock'	17 days.

It appears, therefore, improbable that the 'Zaria' case was infected from the 'Elizabeth Brock.'

Cases 21, 22, 23, 24

These cases (Nos. 21, 22, 23, 24) are described in Section II, in which they are respectively Cases 39, 46, 47, 48.

All were natives and all occurred on vessels from Lagos, which was at the time in quarantine.

It will be seen on reference to Section II that Case 39 was considered to be suffering from cyclical albuminuria.

As Cases 46, 47, and 48 were the only cases of illness on the respective ships, it is probable that they became infected at Lagos previous to embarkation.

Case 25

The patient was an officer on the s.s. 'Elmina,' a passenger steamer, sailing between Liverpool and the West Coast of Africa. He died on 23rd October, between Forcados and Lagos.

For notes of this case see Dr. Leonard's Report, Case No. 37, page 287.

The course of the 'Elmina' had been as follows :—

Left Liverpool	10th September.
Las Palmas	16th September.
Sierra Leone	21st September.
Monrovia	22nd September.
Sekondi	24th September.
Cape Coast Castle	25th September.
Accra	25th September.
Lagos Roads	26th September.
Arrived Forcados	27th September.

The vessel was anchored in the river at Forcados one or two days, not less than 300 yards from the shore. She then proceeded to Burutu for about two days, where she moored alongside the wharf. She then returned to Forcados and remained there about two days.

Left Forcados	4th October.
Bonny	5th October.
Arrived Calabar	6th October.

The vessel was anchored in the river at Bonny not less than 200 yards, and at Calabar not less than 300 yards, from the shore, except for one day at Calabar, when she was moored alongside the wharf.

Left Calabar	12th October.
Bonny	13th October.
Arrived Forcados	14th October.

The vessel was at Forcados and at Burutu on the return for about the same time as on the outward voyage.

Left Forcados	22nd October.
Lagos Roads	23rd October.

At all ports of call in Africa the vessel lay in the Roads about 1—2 miles from the shore, with the exception of Sierra Leone (anchorage in the harbour not less than approximately 200 yards from the shore), Forcados, Burutu, Calabar, and Bonny (as described). I am informed that it is improbable that the patient was ashore at night anywhere, except possibly at Burutu. As is usual, the vessel embarked a native crew on the outward voyage at Sierra Leone. The number of Europeans on board at the time of reaching Lagos on the homeward voyage was approximately eighty. The number of natives was approximately forty.

Special inquiry was kindly made, at my request, by Messrs. Elder Dempster

and Company's Agent at Lagos, upon the return of the 'Elmina' to Nigeria, as to whether any deaths or any suspicious cases of fever had occurred on the vessel subsequent to the present case. He informed me that none had occurred. The inference in this, as in the other instances in this section of isolated cases on ships, is that the patient was infected from a native source ashore.

Prophylactic use of quinine and mosquito net by the patient—unknown.

Case 26. L. 129

This case occurred on the s.s. 'Monrovia,' a cargo boat, at Calabar, on 26th October. He was admitted to hospital on the same day.

For clinical notes of this case see Dr. Leonard's Report, Case No. 38, page 289.

The course of the vessel had been as follows :—

Left Hamburg	6th August.
Port Talbot (S. Wales) ...	10-30th August.
Sierra Leone	13-16th September.
Sekondi	20-21st September.
Accra	21-24th September.
Lagos Roads	25-27th September.
Forcados	28th September to 20th October.
Arrived Calabar	22nd October.

On arrival at the West Coast of Africa, a native crew had been embarked.

The vessel had not been alongside the wharf at Forcados or Burutu. It is probable, however, that lighters or 'branch-boats' were alongside, but I have been unable to ascertain this definitely. She was alongside the wharf at Calabar for four days prior to admission of the patient to hospital. It is not known whether he was ever ashore, or whether he used a mosquito net or took quinine for prophylaxis.

No suspicious cases were reported from Calabar either before or after the 'Monrovia's' visit, and no other cases occurred on board.

Cases 27, 28, 29. L. 102,† 103,† 104†

These cases occurred on the cargo-steamer 'Elizabeth Brock.'

Case 27 died on board the vessel on the 26th October, before being seen by a Medical Officer : the body was brought ashore for post-mortem examination.

Cases 28 and 29 were admitted to Lagos Hospital on the 26th October.

Quinine prophylaxis.—Every European, including the patients, received one gramme of quinine every five days whilst on the Coast.

It is not known whether the patients used mosquito nets.

They were said not to have been ashore since the arrival of the vessel on the Coast.

For clinical notes of these cases see Dr. Leonard's Report, Case No. 29, page 274, Case No. 30, page 276, and Case No. 31, page 278.

The itinerary of the vessel had been the following as nearly as can be ascertained :—

Forcados	23-30th September.
Calabar	2-5th October.
Opobo	6th October.
Bonny	11th October.

She then proceeded to Buguma, Abonnema, Degema, and returned to :—

Bonny	16th October.
Calabar	17th October.
Oron	19th October.
Calabar	21st October.

She left Calabar on the 21st October and arrived at Lagos on the 24th October. Deck (native) passengers had been carried as follows :—

10 from Cape Palmas to Lagos.
5 from Cape Palmas to Bonny.
27 from Cape Palmas to Opobo.
7 from Cape Palmas to Calabar.

No suspicious cases had occurred prior to the ship's arrival either at Calabar, Bonny, Opobo or Degema. There is no Medical Officer stationed at Buguma, Abonnema, or Oron.

It will be seen on reference to Section II of this Report that numerous cases in natives were occurring about this time at Forcados, where the vessel had remained for one week, and where (as also at Calabar) branch-boats had been moored alongside.

The fact that the 'Elizabeth Brock' and the 'Zaria' were together at Opobo on the 6th October and that a passenger was transferred from the former to the latter is interesting. It will be remembered that an officer of the s.s. 'Zaria' died of yellow fever at Forcados on the 18th October (Case 20), and that he first became ill about the 9th to 13th October, *i.e.*, 3-7 days after the ships had been together at Opobo. The 'Elizabeth Brock' patients first became ill 17-18 days after the vessels had been together. Both vessels had called at Forcados, Opobo, Bonny, Buguma and Abonnema, but simultaneously only at Forcados and Opobo.

Case 30. L. 105†

This case occurred on the s.s. 'Bassa,' a branch-boat plying between Lagos and Forcados, and was admitted into Lagos Hospital on the 26th November. The patient first felt ill on the 21st November, while the vessel was at Forcados, and on the instructions of the master, he called upon Messrs. Elder Dempster's Medical Officer at that port.

'On his return to the ship, he informed the master that he had a temperature above normal and he was immediately ordered to his room. His temperature appears to have fluctuated somewhat from that date onwards' (extract from letter from Messrs. Elder Dempster's Agent, Lagos).

When Dr. Gray saw the patient at 8.20 a.m., on 26th November at Lagos, the temperature was 102° Fahr., pulse 92. There was no vomiting. Frontal headache and loin pains were complained of. The patient was sent into hospital.

It is not known whether he was a quinine taker or used a mosquito net.

For clinical notes of this case see Dr. Leonard's Report, Case No. 32, page 279.

The 'Bassa' is a branch-boat plying between Lagos and Forcados. She had arrived from the latter port on the 24th November, having sailed on the preceding day. Her movements for some weeks previously had been as follows :—

Left Lagos	1st October.
Arrived Forcados	2nd October.
Left Forcados	16th October.
Arrived Lagos	17th October.
Left Lagos	7th November.

Arrived Forcados	8th November.
Left Forcados	15th November.
Arrived Burutu	15th November.
Left Burutu	16th November.
Arrived Forcados	16th November.
Left Forcados	23rd November.
Arrived Lagos	24th November.

It will have been seen (Section II), that cases in natives occurred at Forcados in October and November, and I understood that the patient was probably ashore on various occasions after sunset during the two periods (each of about two weeks' duration) when the vessel was at that port.

Upon her arrival at Lagos, on the 24th November, she was moored alongside the wharf.

CASE 31. *Commission number not obtainable*

This case was diagnosed as malignant malaria.

In view of the cases of yellow fever that had occurred recently in Nigeria, it will be seen that the differential diagnosis will have been a matter of some nicety.

The patient died at Port Harcourt five days after his arrival, and I include the case in this series as it is possible that he may have become infected on shipboard.

The following is a copy of the clinical and post-mortem notes by the Medical Officer at Port Harcourt:—

> The deceased left Accra on 22nd November, and, staying six days at Lagos, arrived at Port Harcourt on the 2nd December. He had been abroad before this tour in the tropics. Little else is known of him here, except that he was very slow in his speech and that a bottle of quinine bisulphate was found in his baggage.
>
> On 6th December, at 6 a.m., I was summoned to him by his cook, who had just found him lying on the ground unconscious, having fallen off his bed through his mosquito net. His tent and the contents thereof were in apparent order. He was vomiting, with incontinence of urine and faeces, Breathing, stertorous. Pupils, equal, active, and normal. Temperature. 103° Fahr. Pulse, 110. Respirations, 36. No sign of jaundice. Urine contained a trace of albumen, which did not increase in amount later. The vomit had no unusual character at first, but later was bilious. Faeces appeared normal. Active measures for malarial coma were taken, but there was no sign of improvement until that night at 11 p.m. From then until his death he remained semi-conscious.
>
> The following notes show the treatment and course of the case:—
>
> *6th December.*—6 a.m.: Quin. bihyd., 15 grains, intramuscularly. 6.30 a.m.: Quin. bihyd., 15 grains, per rectum. 7.30 a.m.: Quin. bihyd., 20 grains, per rectum; hot packs started. 8 a.m.: Quin. bihyd., 10 grains, whisky 2 ounces, per rectum. 9.30 a.m.: Ditto. 11.30 a.m.: Ditto. 1.30 p.m.: Packs stopped. 2.0 p.m.: Quin. bihyd., 5 grains, whisky 2 ounces, per rectum; profuse sweating. 3.0 p.m.: Dried and rubbed down. 3.30 p.m.: Tepid sponging. 5.0 p.m.: Ice pack to head. 6.0 p.m.: Whisky 1 ounce, per rectum; ice packs. 7 p.m.: Ice packs. 8.0 p.m.: Quin. bihyd., 5 grains, whisky 1 ounce, per rectum; ice packs. 9.0 p.m.: Whisky 1 ounce, per rectum; ice packs. 11.0 p.m.: Whisky 1 ounce, per rectum. Midnight: Semi-conscious.

7th December.—2.30 a.m.: Whisky 1 ounce, per rectum. 5.0 a.m.: Whisky 1 ounce, per rectum. 7.0 a.m.: Whisky 1 ounce, per rectum. 1.0 p.m.: Delirious. 3.30 p.m.: Quin. bihyd., 10 grains, whisky 1 ounce, per rectum; ice packs. 4.0 p.m.: Ice packs. 4.30 p.m.: Ditto. 5.30 p.m.: Ditto. 6 p.m.: Enema saponis; ice packs. 7.0 p.m.: Whisky 1 ounce, per rectum. 8.0 p.m.: Quin. bihyd., 10 grains, whisky 1 ounce, per rectum; ice packs. 9.0 p.m.: Whisky 1 ounce, per rectum; ice packs. 10.0 p.m.: Whisky 1 ounce, per rectum; ice packs.

Death took place at 10.30 p.m. on 7th December.

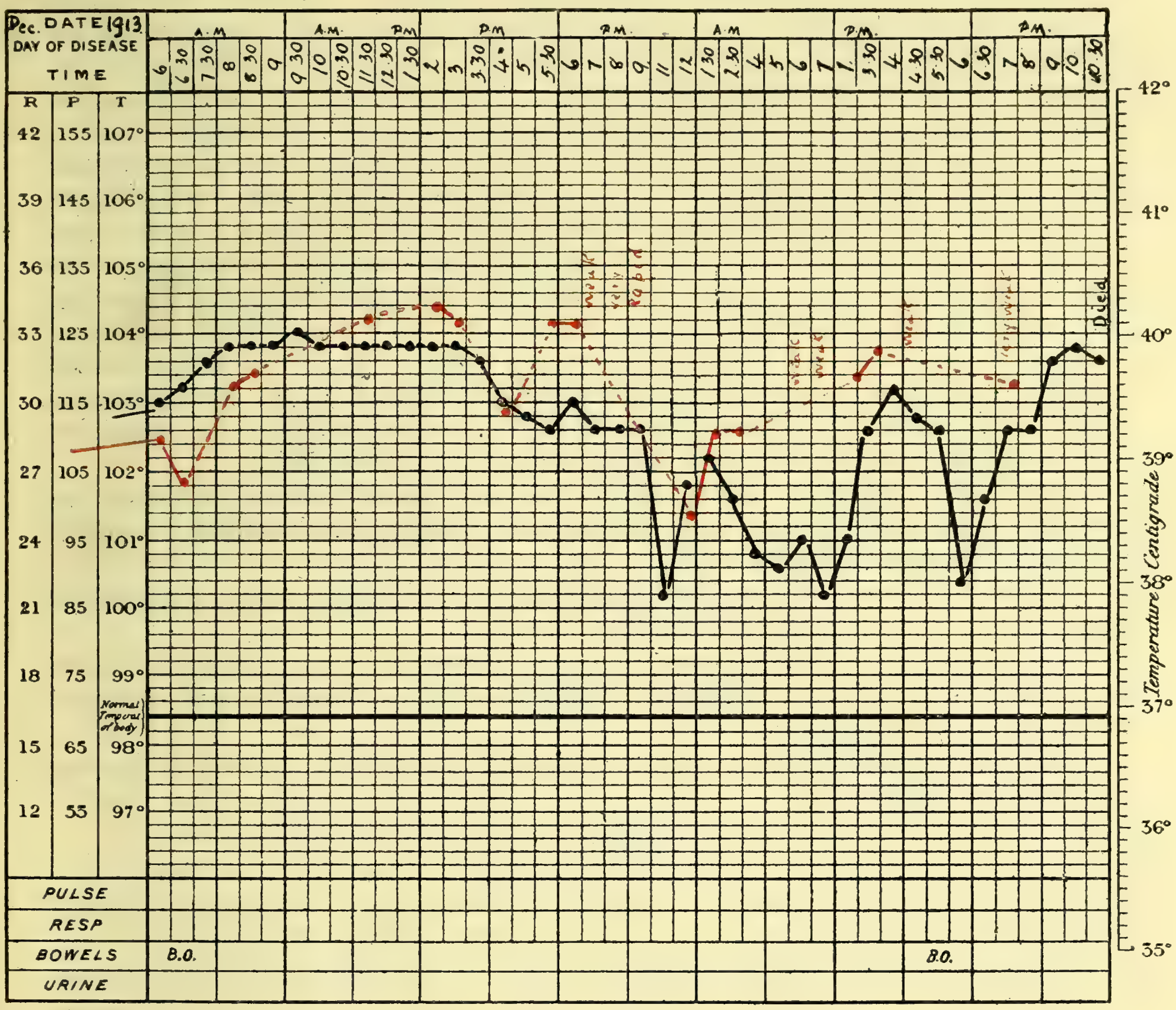

Chart 73

Post-mortem Examination, 10 *a.m.,* 8*th December.*

No trace of jaundice or subcutaneous haemorrhages. Rigor mortis well marked.

Brain.—Vessels markedly congested, substance rather soft.

Heart.—Coronary vessels dilated, with all the chambers distended with blood and ante- and post-mortem clots. Valves competent. Muscle healthy, but pale.

Lungs.—Congested. Otherwise appeared normal.

Liver.—Nearly double normal size, firm, cloudy swelling, no evidence of yellow coloration in the liver substance.

Gall bladder.—Distended with bile.

Spleen.—Slightly enlarged, smooth, dull plum-colour, substance dark and softish.

Kidneys.—Pale. Constituents otherwise seemed normal.

Stomach and bowels.—Did not appear unduly congested. There was no bile-staining nor submucous haemorrhage evident. Contents appeared normal, except for bile-stained mucus in the stomach.

The patient left Accra on the 22nd November by the s.s. 'Akabo,' and arrived at Lagos on 24th November. He stayed at Lagos until the 29th November, when he embarked on the s.s. 'Karina' for Forcados. Here he re-embarked on the 'Akabo' for Bonny on the 30th November. From Bonny he proceeded to Port Harcourt by river craft (? launch), and arrived there on 2nd December.

During his sojourn at Lagos, *i.e.*, up to eight days before he was seen by the Port Harcourt Medical Officer, he stayed at an hotel, where, upon inquiry from the proprietor, I was informed that he had impressed him as being a 'steady' man and not a 'heavy drinker.' (The standard of vendors of alcoholic liquor as to what constitutes 'heavy drinking' is, of course, an indeterminate one.) On inspecting the hostelry (which had been fumigated some time before the patient's arrival, in connection with a native case of yellow fever) I found that all beds were provided with nets, but in several unoccupied rooms I observed that the net was allowed to hang loose in such a way as to allow ready ingress to mosquitoes. The proprietor was unable to point out the room which the patient had occupied.

By an acquaintance of the deceased in Lagos I was informed that he was in the habit of taking five grains of quinine daily, and that he was a 'quiet,' 'regular,' methodical and abstemious man.

No cases of fever of a suspicious character are reported to have occurred on the 'Akabo' or the 'Karina,' or at Port Harcourt.

The 'Akabo,' on which the patient travelled from Forcados to Bonny had been several days at Forcados and Burutu (under conditions similar to the 'Elmina,' which see under Case 25.)

It will be remembered that several anomalous cases of fever in natives occurred at Forcados at this time.

Case 32. L. 107†

This patient was a steward on the s.s. 'Montenegro.' He died on 24th December on the launch which was conveying him to Lagos Hospital.

The captain of the vessel informed me that the deceased had taken five grains of quinine daily since arrival on the West African Coast, and that he always used a mosquito net.

For clinical notes of this case see Dr. Leonard's Report, Case No. 34, page 283.

The course of the s.s. 'Montenegro' had been as follows:—

Left Port Talbot (South Wales) ...	28th October.
Arrived Sierra Leone	12th November.
Left Sierra Leone	12th November.
Arrived Sekondi	17th November.
Left Sekondi	12th December.
Arrived Lagos	14th December.

At Sierra Leone the vessel was anchored half a mile from the shore, in the harbour. She here embarked a native crew (53).

At Sekondi the vessel was anchored in the Roads, 1—2 miles from the shore. She remained there for over three weeks and embarked 61 native passengers.

On arrival in Lagos Harbour the ship anchored, on account of her draught, at Wilmot Point, more than a mile from the wharves and usual anchorages and from the native town. She remained there from the 14th to 19th December and then went alongside the wharf at Iddo. Iddo is the railway terminus and is situated on the opposite side of the Lagoon to Lagos, being joined to the town by a bridge approximately 700 yards in length. Near the Lagos end of the bridge, a case of yellow fever in a native had occurred on 27th August, and *Stegomyia fasciata* had been found in the infected area. The vessel remained alongside the Iddo wharf from 19th December until the death of the patient on the 24th. The patient, I was informed, had been ashore at all ports of call, including Lagos.

There is a sparse native population at Iddo. About 250 yards from the wharf there is a small group of native houses, and about half-a-mile distant there is a little village. With these exceptions the native population consists of the servants attached to some half-dozen houses and several watchmen, who guard the stores and sheds near the railway at night. These stores and sheds are about 100 yards from the wharf, the houses approximately 200 to 500 yards.

Stegomyia fasciata is present at Iddo.

The number of persons on the vessel at Iddo at the time of the patient's illness was as follows :—

Europeans (not including the patient)	24
Creole	1
Natives	64

As no other cases of the disease occurred on the vessel it is to be supposed that the patient became infected ashore at Lagos. It was not possible to trace the movements of the deceased when away from the ship. The captain informed me that he may very possibly have been ashore at night.

Case 33. L. 119

This patient, an officer of the s.s. 'Nyanga,' a cargo-boat, died in Lagos Roads on board that vessel on 28th December.

The Medical Officer, Lagos, arrived on board at 4.30 p.m., shortly before death. He diagnosed yellow fever. He found the patient, who had just vomited some black-looking fluid, unconscious and cyanosed, and on his singlet was a black stain, looking like 'coffee-ground vomit.'

For clinical notes of this case see Dr. Leonard's Report, Case No. 35, page 284.

The course of the 'Nyanga' had been as follows :—

Left Hamburg ... ... 21st October.
(There were on board 18 Europeans and 10 native firemen.)
Rotterdam ... ... 23rd-26th October.
Monrovia (sea anchorage) ... ... 11th-12th November.
(62 Kroomen and 5 small boys were embarked here.)
Lagos (alongside wharf) ... ... 15th-20th November.
Manoka (German West Africa) ... 22nd November.
Calabar ... ... 24th-27th November.
(Anchored in river about 300 yards from shore.)
Oron ... ... 27th-28th November.
(Anchored in river about 200 yards from shore.)

Opobo	29th Nov.—5th Dec.
(Anchored in river about 300 yards from shore.)	
Brass	6th-8th December.
(Anchored in river about 300 yards from shore.)	
Bonny	8th-9th December.
(Anchored in river about 300 yards from shore.)	
Okrika	9th-11th December.
(Anchored in river about 100 yards from shore.)	
Bakana	11th-12th December.
(Anchored in river about 200 yards from shore.)	
Degema	12th-14th December.
(Anchored in river about 300 yards from shore.)	
Abonnema	14th-16th December.
(Anchored in river about 300 yards from shore.)	
Buguma	16th-17th December.
(Anchored in river about 200 yards from shore.)	
Bonny	17th December.
Calabar	18th-19th December.
(Alongside wharf on 18th December.)	
Oron	19th-20th December.
(Anchored in river about 200 yards from shore.)	
Calabar	20th-21st December.
(Anchored in river about 300 yards from shore.)	
Lagos	23rd-26th December.

The vessel was anchored at Wilmot Point more than a mile from the wharves and usual anchorages and from the native town.

On the 23rd, 24th, and 25th, three branch-boats were moored alongside at various times. Two of these were alongside at night.

On the 26th the ship crossed the bar and lay in the Roads.

The captain informed me that the patient did not go on board the branch-boats and that throughout the voyage he was ashore on only one occasion. This was at Oron, on 19th December (six days previous to the onset of his illness), from eight to ten o'clock in the evening, when he was on duty in a palm-kernel shed.

I was further informed that the deceased was on his second voyage to the West Coast of Africa ; that he always used a mosquito net, but was a non-quinine taker.

No other cases occurred on board the vessel during the four days she remained in Lagos Roads after the patient's death. She had, of course, been fumigated immediately after the case was diagnosed. Two mosquitoes were caught on the ship, but neither proved to be *Stegomyia fasciata*.

No cases occurred on the branch-boats which had been alongside.

It is to be presumed that the patient became infected ashore at Oron and (in the absence of European cases of the disease in that locality) from a native source.

Summary and Conclusions

1.—Thirty-three cases have been dealt with in this section. Six of these were natives of West Africa, the remaining twenty-seven were Europeans.

2.—Twelve out of the thirty-three cases were definitely diagnosed

as yellow fever. Of the remaining twenty-one cases, three—Nos. 17, 18, 19—are of a highly suspicious character; seven—Nos. 4, 6, 7, 11, 16, 25, 31—are certainly suspicious; Nos. 4, 6, 7, and 25, being of special interest as cases of hyperpyrexia (one of the subjects of inquiry of the Yellow Fever Commission); whilst the remaining eleven present suggestive features.

3.—In discussing the epidemiology of these cases they have all been assumed to be yellow fever.

4.—All except Nos. 15, 16 on the 'Lulu Bohlen,' Nos. 17, 18, 19 on the 'Thomas Holt,' and Nos. 27, 28, 29 on the 'Elizabeth Brock,' occurred as *single* cases. Two cases occurred on the 'Sandgrouse' dredger, but at an interval of three months.

5.—It is to be inferred that, at any rate, in the case of those ships where *single* cases occurred the patients were infected whilst ashore. Had the vessels themselves been infected it is hardly to be supposed that they would have presented only solitary cases of the disease. On small ships on which occurred cases 2, 3, 10, 11, 12, 13, 14, 21, 22, 23, 24, 30, there would be not less than three or four Europeans living in close association. On larger ships (not carrying European passengers), on which occurred cases 1, 4, 6, 7, 8, 15, 16, 17, 18, 19, 20, 25, 26, 27, 28, 29, 32, 33, there would be approximately eighteen or more Europeans. The exact numbers have been stated in those cases where it has been possible to ascertain them.

6.—If the patients on those ships where single cases occurred were infected ashore, their infection must, in the absence of European cases and excluding a possible animal reservoir, have been obtained from a native source.

7.—Now, as far as can be ascertained, none of these cases, with the possible exceptions of Nos. 6, 8, 20, could have become infected from a European source. Cases 1 to 11 occurred before any European case had been reported. Cases 15 to 19 (on vessels at Warri) occurred at least two months after the last European case was reported from Warri, and neither vessel had called at Lagos, where European and Syrian cases had been reported at intervals from May onwards. The ship on which case 17 occurred had called neither at Lagos nor at Warri. It is, however, possible that mild, atypical cases of the disease have occurred in Europeans and have

remained unrecognized, and therefore the possibility of contact with infective Europeans cannot be entirely excluded.

8.—The balance of evidence appears to point to the conclusion that the single and the first of the multiple cases which occurred on ships were infected from a native source. Support is given to this conclusion by the well-known fact that sailors live carelessly when ashore, and it will be remembered that, of the thirty-three cases described, twenty-six were European seamen of various grades.

9.—In no case is there evidence of the disease having been introduced into Nigeria from a neighbouring dependency.

The following is a list of the places in West Africa where yellow fever occurred in 1913 :—

Grand Popo (Dahomey): Quarantine, 19th February—12th March.
Accra (Gold Coast): Quarantine, 15th March—14th April.
Warri (Nigeria): Quarantine, 13th June—30th June.
Accra (Gold Coast): Quarantine, 16th June—3rd July.
Lagos: Quarantine, 21st July—16th September.
Lagos: Quarantine, 4th October—5th November.

Single cases of yellow fever—quarantine not imposed—were reported from the following places :—

Saltpond (Gold Coast): 18th January. Occurred on s.s. 'Adansi,' lying in the Roads. Case imported from Nigeria.
Grand Popo—Agone (Dahomey): 2nd May.
Abokobi (Gold Coast): 14th May.
Quittah (Gold Coast): 2nd July.
Lome (Togoland): 13th September.
Forcados (Nigeria): 20th October.
Lagos: 26th November. Occurred on s.s. 'Bassa.'
Lagos: 24th December. Occurred on s.s. 'Montenegro.'
Lagos: 28th December. Occurred on s.s. 'Nyanga.'

Appendix I

Case A

Race: European.
Age: —.
Sex: Male.
Occupation: Clerk.
Date of admission to Warri Hospital: 15th October, 1912.
Date of discharge: 19th October, 1912.
Diagnosis: Febricula.

Copy of notes on the case.—' Blood examination negative. Bowels well opened before arrival. Patient is a non-quinine taker. Admitted day after onset. Nothing apparently wrong save rise of temperature; tongue clean; no aches or pains; no suffusion of eyeballs; is it malaria? is it sand-fly fever?'

The patient was treated with quinine, 5 grains four-hourly, for two days, and then thrice daily. He also received one hypodermic injection of quinine. He was again admitted for the same condition on the 11th January, 1913, and discharged on the 18th January. The blood examination was again negative. He received a hypodermic injection of quinine on admission, and subsequently Quin. Hydrochlor., 5 grains (three doses), on the 12th, $2\frac{1}{2}$ grains four-hourly on the 13th and 14th, and $2\frac{1}{2}$ grains three times a day on the 15th January.

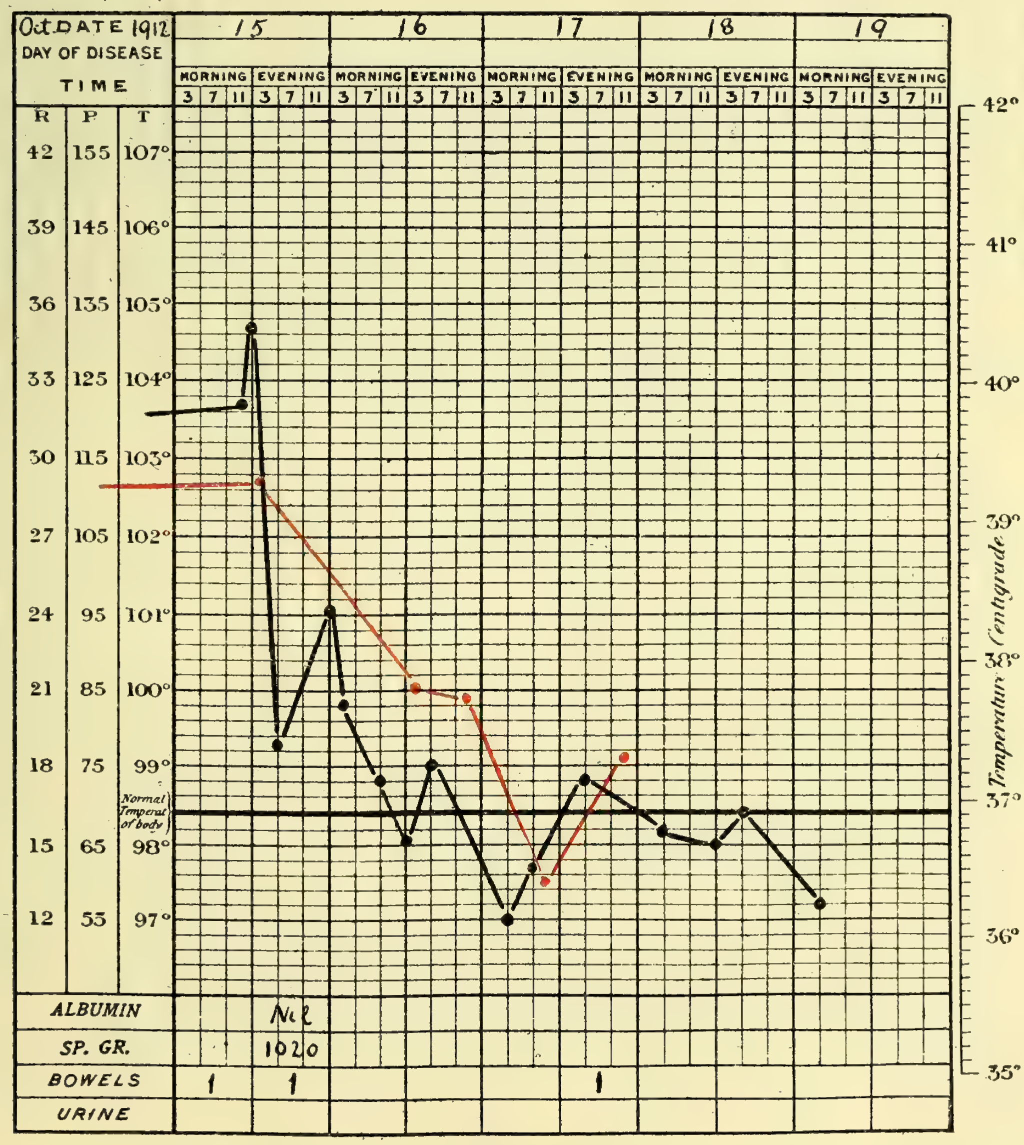

Chart 74

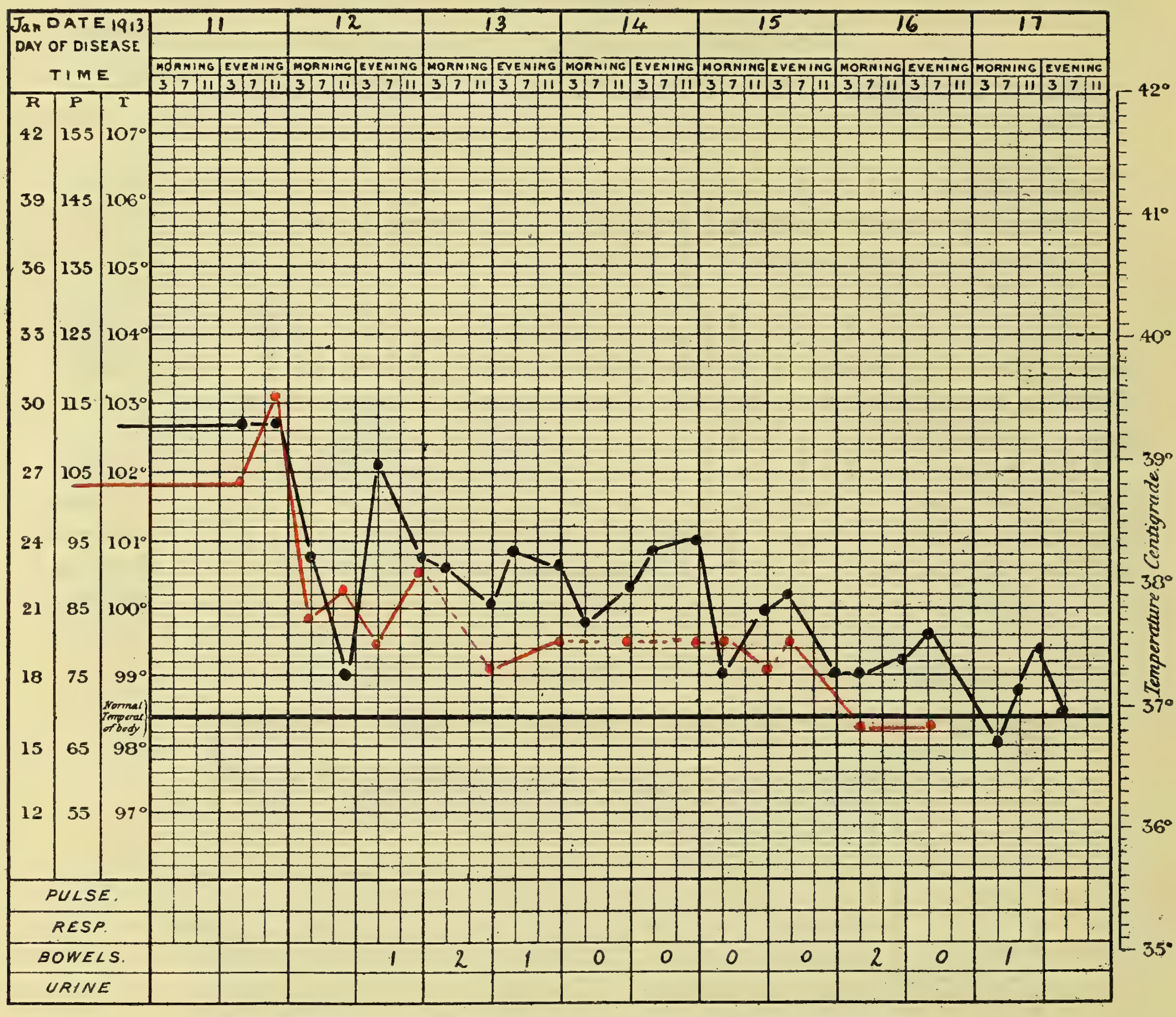

Chart 75. Case A, second admission to hospital

Case B

Race : European.

Age : —.

Sex : Male.

Occupation : Government official.

Date of admission to Warri Hospital : 24th September, 1912.

Date of discharge : 5th October, 1912.

Diagnosis : Febricula.

Copy of notes of the case.—'Blood examination negative. A case of simple continued fever, due, in my opinion, to gastro-intestinal auto-intoxication. A highly neurotic individual, who suffers from chronic indigestion.'

This patient received a daily dose of Quin. Hydrochlor., 5 grains, after the 27th September.

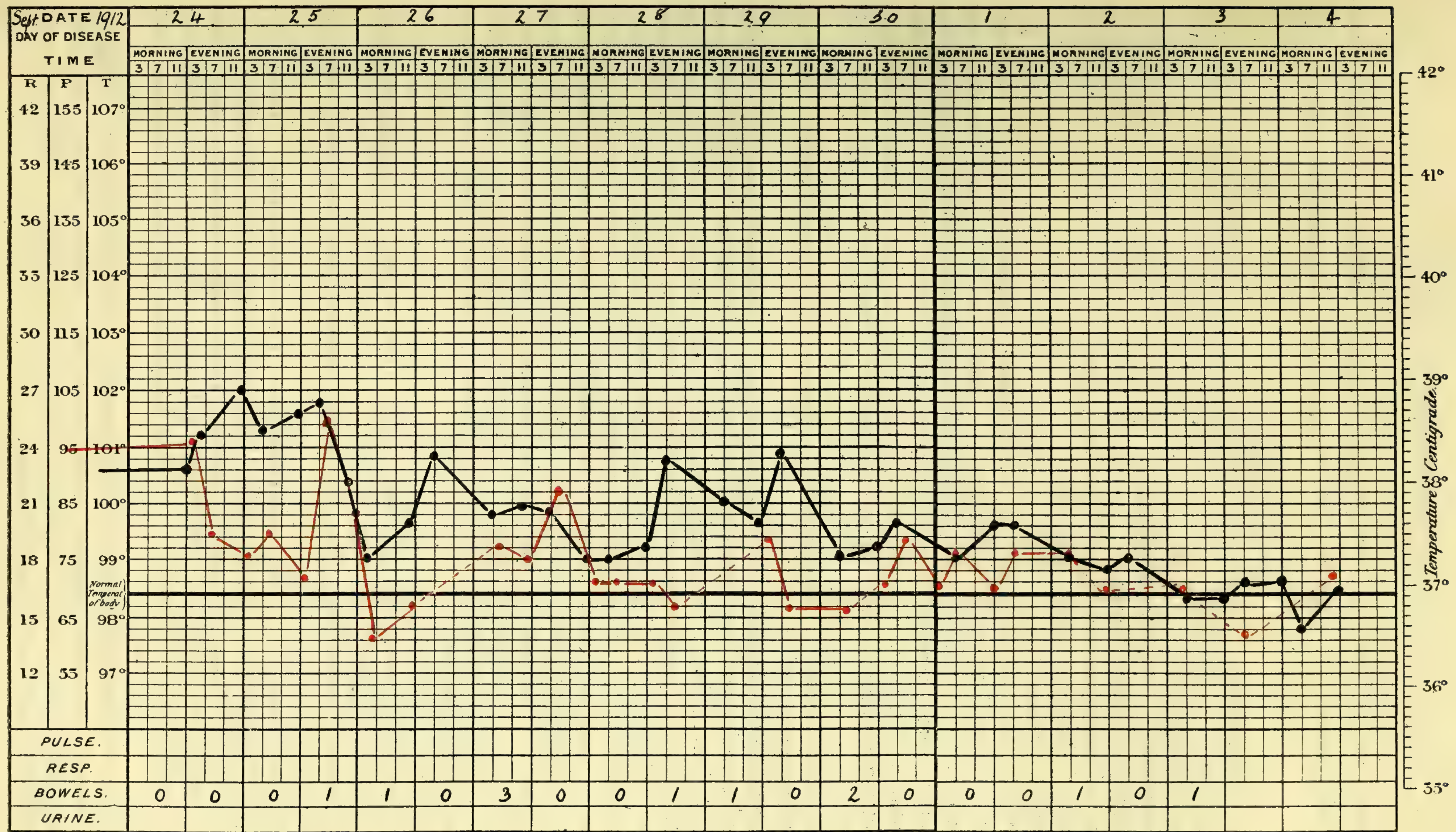

Chart 76. Case B

Appendix II

Extract of Notes by the then Medical Officers of two cases diagnosed as Enteric Fever at Sapele in 1906 *and* 1913

Case I

Race: European.
Age: 28.
Sex: Male.
Occupation: Government official.
Diagnosis: Enteric fever.
Date of admission to hospital: 1st June, 1906.
Date of discharge: 28th July, 1906.
Result: Invalided.

Previous history.—Smallpox in Sierra Leone. Malarial fever in Northern Nigeria. First tour Southern Nigeria—no malaria as yet. Some diarrhoea ten days ago, and for about a week has suffered from headache and anorexia. Has felt 'out of sorts,' especially since 29th May, but continued work, thinking that he would be all right in a day or two. Took to bed on 31st May in the evening, and had some quinine. Seen by me in afternoon of 1st June on my return from Koko.

Complaint.—Patient complains only of fever—he has no headache. No pain nor discomfort anywhere.

Examination.—General: Face slightly flushed. Anxious expression. Depression underneath eyes. Respiration easy but somewhat shallow. Slight occasional cough. Patient restless. Twitching of muscles. Later, muttering delirium—but, on speaking to patient, sensible answer after a minute or two. Particular: Temperature 106°. Pulse, 76. Radials soft, tension moderate, volume moderate. Tongue, thick, yellowish fur, edges red; tremulous. Thorax, heart—no abnormality detected; lungs, expiratory murmur noticeable, otherwise normal. Abdomen, slightly depressed but not navicular; no tenderness; tympanitic all over; liver not enlarged; spleen not palpable and *not* tender. Urine, deep amber in colour: sp. gr. 1030; no albumen, blood, nor sediment. Faeces, normal colour, soft, formed; not abnormally offensive; no blood or mucus. Blood, no parasites seen; slight leucocytosis.

Treatment: Milk diet.

1st June.—Warburg's tinct. ½-ounce. Pil. Opii. 1 grain. Calomel 3 grains. Quin. Bisulph. 10 grains.

2nd June.—Phenacetin, 15 grains. Quin. Bisulph. (total 20 grains) the last 5 grains given in cachet.

3rd June.—No change. Muttering delirium. Little or no sleep. Treatment: Vomited Quin. Bisulph., so gave Quin. Hyd. 10 grains, made up in cachet.

4th June.—Tongue dry and brownish. Temperature down to 102·4° but rapidly rose again to 105·8°. Muttering delirium. Pulse still slow—moderate tension and volume. Treatment: Tried Euquinine, 10 grains, morning and evening.

5th June.—Urine, sp. gr. 1022; trace albumen; deep amber colour. Tongue, dry; brown; tranverse fissures; edges very red. Motion to-day distinctly offensive for the first time. Treatment: Euquinine 10 grains. Milk diet; egg flip; milk and soda; sol. of egg albumen.

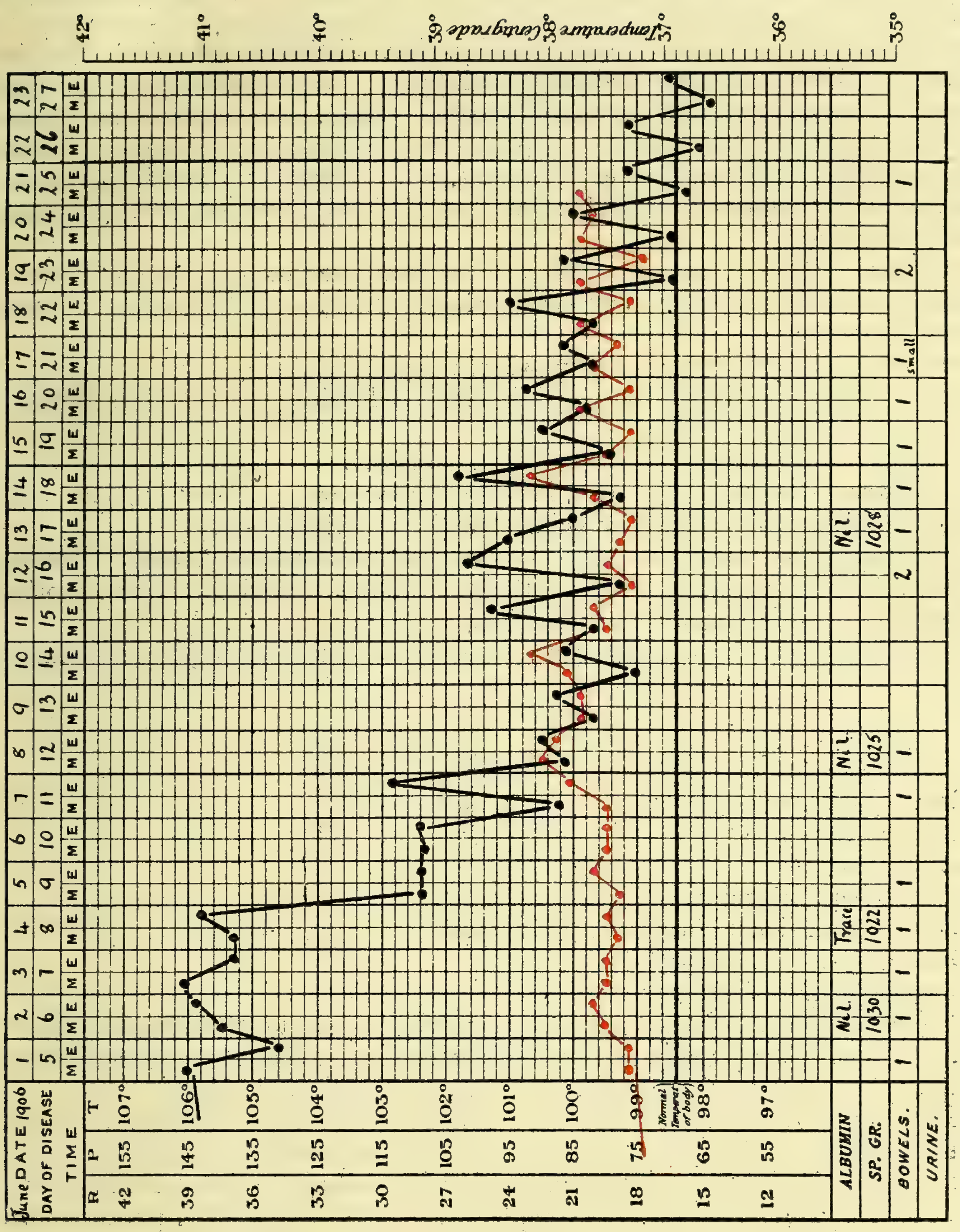

Chart 77. Case I

6th June.—Temperature between 102° and 103° all day. No other change. Still delirium. No motion. Little or no sleep. Possible typhoid. Less possibly tubercular. Treatment: Diet continued as before. Given a mixture containing Liq. Hydrarg. Perchlor., Quin. Hydr., Tr. Card. Co.

7th June.—Dr. Roe arrived. Saw patient with me and declared for typhoid. Motion slight and constipated. Treatment: As before. Grey powder, 1 grain, at night.

8th June.—Good motion for quantity, but distinctly offensive. Positive Widal's test with locally prepared bouillon culture. Pulse a little more feeble and distinctly higher rate—highest 90 per minute. Urine, deep amber; no deposit on centrifugalizing; no albumen; sp. gr. 1028. Temperature coming down. Still muttering delirium, but less frequent, and cerebration slightly improved. Large motion—unformed. Good colour but distinctly offensive odour. Treatment: As before.

9th June.—Patient has slept well for the last three or four days. There is still some muttering delirium and cerebration is still slow. No motion. Treatment: As before.

10th June.—Treatment: Grey powder, 1 grain.

11th June.—Treatment: Rectal injection. Ol. Ric. ½ ounce. Ol. Olivae 5 ounces.

12th June.—Treatment: Grey powder, 1 grain.

13th June.—No motion on 10th, in spite of grey powder. On 12th there were two good motions—the first only being offensive. Urine, normal.

14th June.—No more delirium. Cerebration approaching normal. Tongue cleaning rapidly; edges no longer red; still slightly tremulous. Small motion this morning—semi-formed; not offensive.

The further course was uneventful, the temperature slowly becoming normal.*

Case 2

Race: European.
Age: 40 (about).
Sex: Male.
Occupation: Merchant.
Date of admission to hospital: 5th September, 1913.
Date of death: 11th September, 1913.
Diagnosis: Enteric fever.

The patient had been in hospital from 7th August to 18th August, 1913, suffering from malaria contracted in the Kwale district about two weeks before. He left hospital not quite convalescent, but would not stay longer.

His present illness began more than a week before I was called in. I first saw him on 3rd September, but he would not come into hospital till the evening of the 5th September, when his symptoms were as follows:—Temperature, 103°, pulse, 104. Spleen enlarged. He complained of intense headache, photophobia, sleeplessness, and no desire for food of any sort. Tongue furred. Pupils dilated.

He had been dosing himself with quinine for some time, and was in a very weak state. He was also constipated. Three days before death delirium of a quiet sort set in—it seemed as though his mental powers were dulled. On the day

* *Note.*—At the time of onset of the patient's illness, he had been in Southern Nigeria nearly five months.—E.J.W.

of his death he passed into a state of unconsciousness about 2 p.m. and passed his urine and faeces involuntarily. He also showed marked nervous symptoms, twitching of the fingers, etc., and died at 7 p.m. There was no distant abdominal rash. The urine was albuminous. Treatment: Fluid diet. Quinine by the mouth. Arsenic. Saline aperients.

The following is an extract of the notes of the case when previously admitted for malaria on 7th August, 1913:—Patient came down from Kwale district, where he had been ill for more than a week. He had been dosing himself heavily with quinine. On admission his temperature was 101·2°. Pulse, 96. Tongue moist and slightly furred in the centre. Spleen, enlarged. Liver, normal. Skin, dry. Bowels, constipated. In spite of all treatment his temperature remained above normal until the eighteenth day, and then he insisted on leaving the hospital. Treatment: Quinine hypodermically and by the mouth. Saline aperient, etc.*

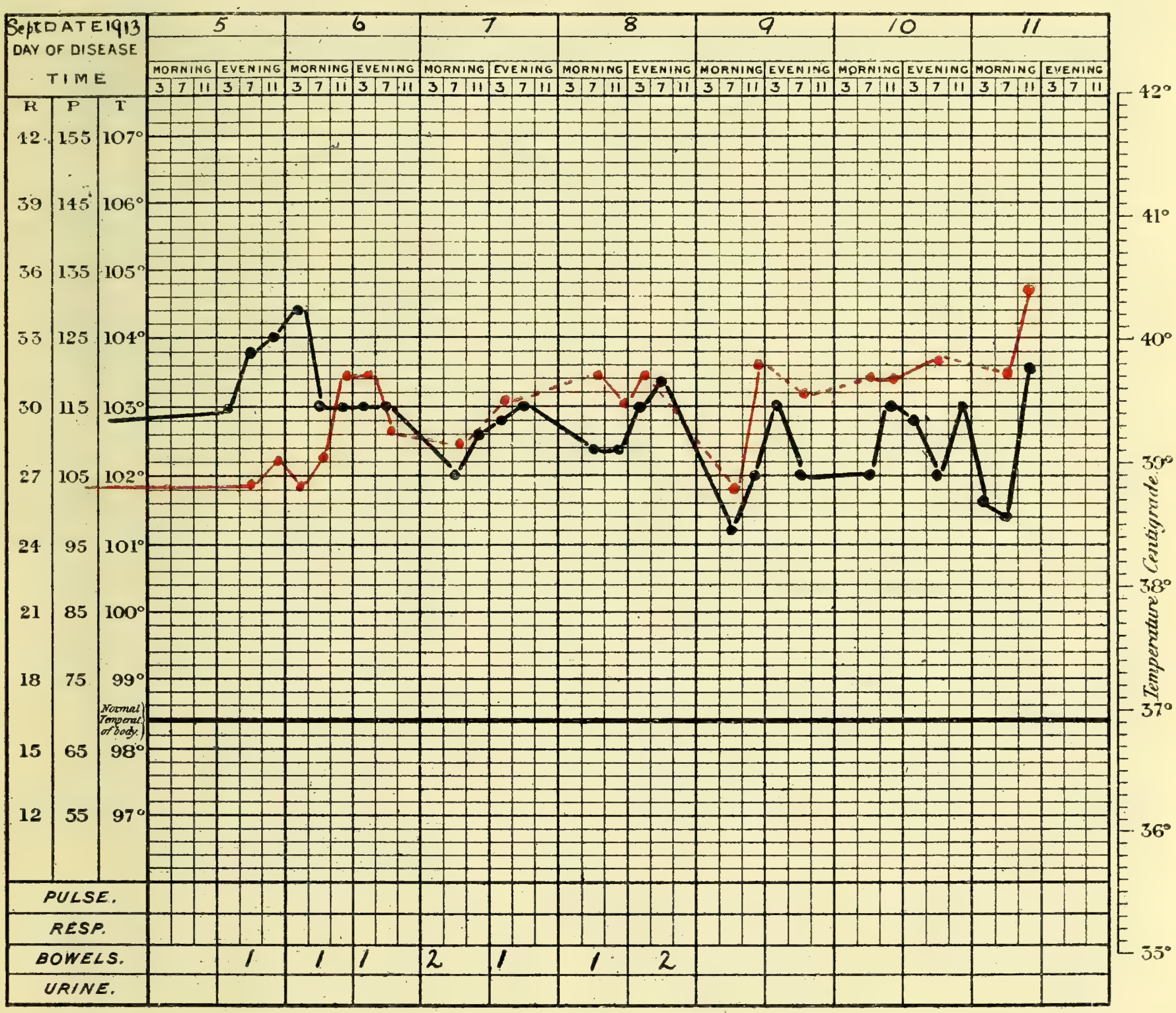

Chart 78

* *Note.*—At the time of the patient's admission to hospital on the first occasion (7th August) he had been in Southern Nigeria between five and six weeks.—E.J.W.

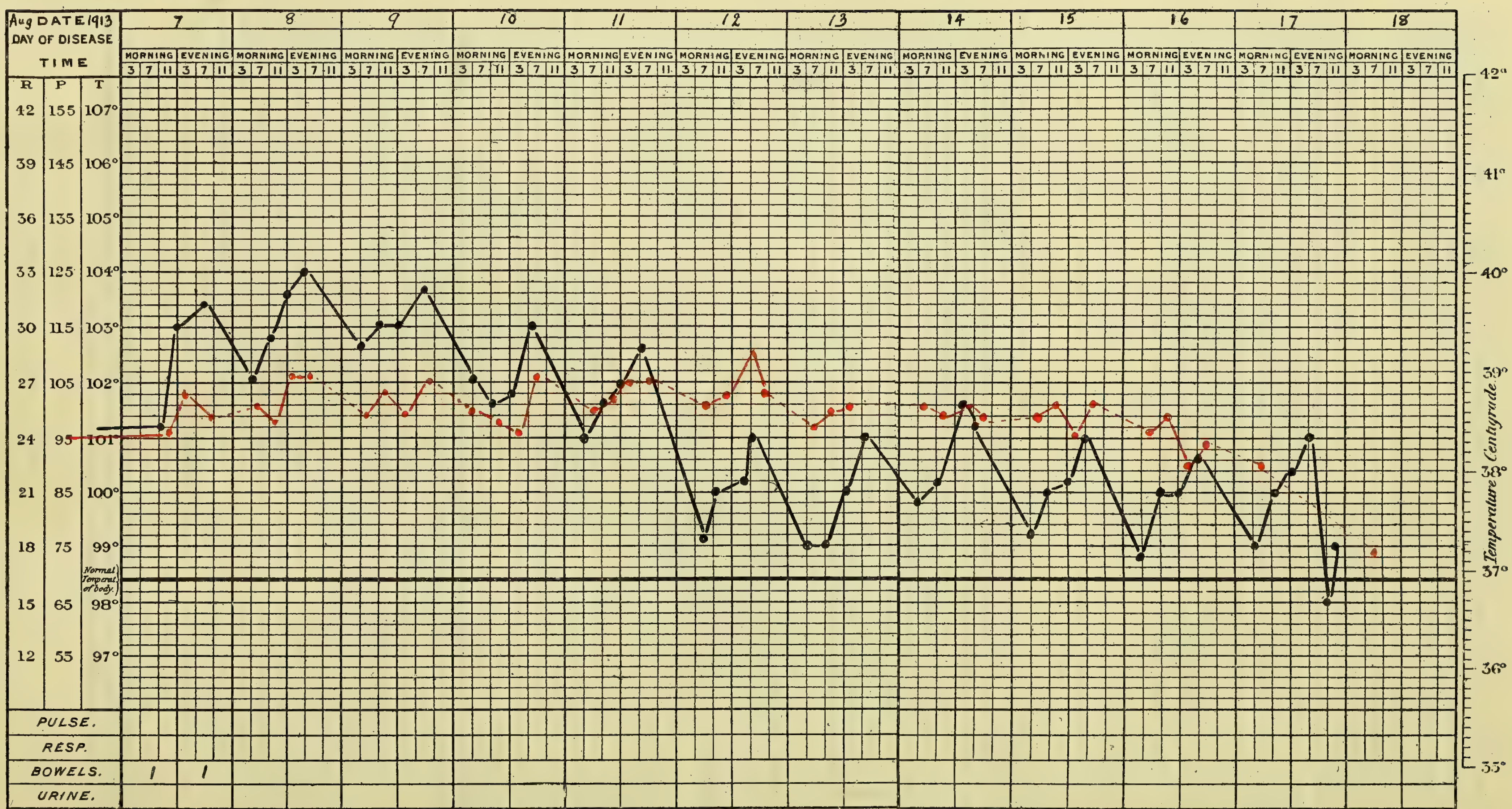

Chart 79. Case 2, previous admission to hospital

APPENDIX III

RECORD OF RAINFALL AND TEMPERATURE OBSERVATIONS AT WARRI

	1911				1912				1913			
	Inches of Rain	Shade Maximum Temperature	Shade Minimum Temperature	Range of Temperature	Inches of Rain	Shade Maximum Temperature	Shade Minimum Temperature	Range of Temperature	Inches of Rain	Shade Maximum Temperature	Shade Minimum Temperature	Range of Temperature
Jan. ...	4·22	96	65	25	1·60	98	69	29	Nil	95	65	30
Feb. ...	1·48	94	60	34	1·50	98	69	29	2·42	95	68	27
March ...	8·52	95	75	20	4·17	99	68	31	4·25	96	68	28
April ...	15·32	94	69	25	10·91	95	69	26	6·10	95	68	27
May ...	14·37	94	69	25	8·51	96	68	28	8·85	95	68	27
June ...	12·92	90	69	21	12·99	90	68	22	9·57	93	68	25
July ...	20·40	87	69	18	23·90	86	68	18	17·64	88	71	17
August ...	4·89	85	67	18	14·50	90	69	21	38·95	89	65	24
Sept. ...	17·52	88	68	20	13·43	87	68	19	19·55	89	68	21
Oct. ...	16·55	92	69	23	15·80	92	68	24	—	—	—	—
Nov. ...	2·74	98	70	28	4·40	94	68	26	—	—	—	—
Dec. ...	Nil	95	64	31	Nil	92	65	27	—	—	—	—

APPENDIX IV

RECORD OF RAINFALL AND AVERAGE MAXIMUM TEMPERATURE IN SHADE AT FORCADOS

	1911		1912		1913	
	Average Maximum Shade Temperature	Inches of Rain	Average Maximum Shade Temperature	Inches of Rain	Average Maximum Shade Temperature	Inches of Rain
	Degrees		Degrees		Degrees	
January ...	96	6·8	91	2·1	93	Nil
February ...	99	2·9	92	1·9	93	7·8
March ...	104	10·25	94	8·8	92	5·56
April ...	100	11·8	95	17·6	92	10·0
May ...	99	13·8	92	16·2	93	20·7
June ...	97	14·2	91	17·3	89	24·1
July ...	94	17·0	89	21·3	82	49·4
August ...	90	0·5	86	19·3	82	39·2
September ...	84	17·0	91	20·7	—	—
October ...	86	24·9	94	27·0	—	—
November ...	89	4·4	89	14·1	—	—
December ...	89	4·8	75	1·4	—	—

Appendix V

Report on the Examination of Organs from Case L. 26*, by Hubert M. Turnbull, M.D., *Director of the Pathological Institute of the London Hospital.*

Macroscopic Examination

Liver. The portion of liver is a slice 6 cms. long, 3·5 cms. broad and 1·0 cm. thick. The capsular surface is smooth. The capsule is flat, thin and transparent, showing a pale yellowish surface, dotted with darker, grey, pin-point areas which give a lobular pattern. The cut surface is of the same pale yellowish colour; on fresh section, however, it is pale green. Minute, greyish portal systems give an apparently normal lobular pattern.

Kidney. A wedge-shaped portion of kidney, having an outer surface measuring 9 by 3·5 cms. and a depth of 2 cms.

The thin capsule has been to a large extent removed. The exposed surface is smooth, of a faintly yellow colour, mottled by darker lines, presumably engorged vessels. On the cut surface the cortex bulges above the level of the medulla and the demarcation between the two is sharp. The cortex has a yellowish grey colour, and on fresh section a faint greenish tint. The pattern is obscure, but can be recognised by the darker colour of the glomeruli in the labyrinths. The cortical pattern is quite straight. The medulla is of a dark slate colour with very dark brown vasa recta. The arcuate vessels are small.

Spleen. A slice of spleen 8 cms. by 3 cms. and 1 cm. thick. The capsule is thin and wrinkled. The cut surface has a ragged appearance suggesting sodden twine, and is of a grey colour. On fresh section the cut surface shows immediately below the capsule a zone, 2 mms. wide, in which there is a pattern formed by white trabeculae in a dark red ground. All the remainder of the freshly cut surface is of a uniform, dirty red colour, smooth and without pattern. These peculiarities are obviously due to the fixatives not having at first permeated the central portions of the spleen.

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* For clinical notes of this case see page 45.

Stomach. The segment of stomach includes 11 cms. of lesser curve and some 22 cms. of greater curve. The cardia is present and has been ligatured. The other extremity appears to have been cut off in the region of the pyloric antrum. A small portion from the cardiac end has been removed, after fixation, presumably for microscopic purposes. The peritoneal surface is for the most part smooth and glistening, in places the lustre is lost, but there is no recognisable deposit of fibrin. The stomach is contracted, the mucosa being thrown into rugae. In the cardiac half of the segment the mucosa is of a deep black colour; in the pyloric half it is almost pure white. The mucosa appears throughout to be swollen, and is slightly mammillated. There are no erosions, nor ulcers.

Microscopic Examination

The tissue was in spirit on receipt. The sections showed, however, that it had at one time been immersed in formalin, a precipitate characteristic of the latter having formed in haemorrhagic areas.

Portions of the above organs were (1) placed in formalin, cut upon the freezing microtome and stained with sudan III and Nile-blue-sulphate; (2) placed in 90 per cent. alcohol, embedded in paraffin, and stained by Ehrlich's haematoxylin and eosin, Weigert's iron-haematoxylin and van Gieson, lithium-carmin and Weigert's elastin stain (Hart), Unna-Pappenheim's stain, Jenner's stain for the demonstration of cellular granules (unpublished method), Twort's stain and the Weigert-Gram method for the demonstration of bacteria, and the Turnbull's blue method for the demonstration of free iron.

Liver. The capsule is thin and even, the lobulation is normal. The fibrous tissue of the portal systems and hepatic veins is not increased.

The majority of the portal systems show a considerable infiltration. The infiltrating cells are lymphocytes and larger, mononuclear, 'free endothelial cells' such as are described in detail in the case of the spleen. Some of these 'free endothelial cells' show karyokinetic figures.

The larger bile ducts contain a few threads of albuminous substance and occasional desquamated cells. A few small droplets of fatty substance are rarely found in the epithelium of the ducts.

There is no abnormality in the structure of the vessels except the presence of a few granules of fat in the cells of the media of many hepatic arteries.

The parenchyma is the seat of conspicuous degeneration. The hepatic cells are greatly swollen, and the capillaries appear to be completely occluded or are only recognised as narrow clefts. In only a few areas are red corpuscles seen in the capillaries. In paraffin sections stained in haematoxylin and eosin, there is usually a zone, two to four cells broad, immediately round the portal systems, in which the cells retain a polygonal shape, are for the most part free from vacuoles and have sharply stained nuclei. Internal to this there is a broad zone in which the protoplasm of the cells contains clear vacuoles of various sizes and is to a greater or less extent hyaline and deeply eosinophil. In the majority of the cells there are no nuclei; in others very faintly stained swollen nuclei can just be recognised. Other nuclei are shrunken and deformed; chromatolysis is, however, much the commonest expression of nuclear degeneration and necrosis. Where the cells can be differentiated they are rounded in shape; in this zone, however, it is usually impossible to differentiate individual cells or even cellular columns. In approximately the central half of the lobules the cells are to a large extent rounded and show a varying degree of vacuolation and hyaline, eosinophilic degeneration of their protoplasm, and chromatolysis, but these changes are much less severe, so that the cellular columns and individual cells can be differentiated. Within the columns of this zone there is a considerable amount of bright yellow bile-pigment.

In sections stained with sudan the outer half of the lobules, with the exception of the narrow zone in the extreme periphery described above, is occupied by a large quantity of fatty substance. The fat does not form large, round droplets which evenly distend signet-shaped cells. The bulk of it is in the form of medium-sized, deeply-stained droplets which lie in groups within degenerate cells. Fine intracellular granules are also present. Occasional large masses of round or irregular shape are extracellular, and obviously

formed by the disintegration of cells. In the central half of the lobules there is much less fat, it is intracellular and in the form of small granules of 'dust.' In sections stained by Nile-blue-sulphate, less fat is demonstrated than in sudan; the smallest granules are not stained; the fat, almost without exception, gives the pink reaction of neutral fat. In preparations of cells crushed in water or in acetic acid and examined with a polarisator very small doubly-refractile bodies are present.

In sections subjected to Turnbull's blue reaction, granules of iron pigment are demonstrated within many of the cells throughout the lobules. The granules are most abundant within the zone of healthier cells in the extreme periphery of the lobules.

Granules of bile pigment are present in the majority of the cells, and are most abundant in the cells of the centre of the lobules.

The kidney. The interstitial tissue is slightly swollen by oedema. The capillaries, particularly those in the medulla, are engorged. The media and intima of the arteries are not altered.

The glomerular tufts are engorged, the cells lining Bowman's capsule are frequently swollen and occasionally desquamated or disintegrated.

The cells lining the first convoluted tubules are greatly swollen, ill-defined, finely granular and faintly eosinophil. Only an occasional cell in any section of a tubule contains a nucleus. Stages of chromatolysis are seen in these tubules. The lumina contain a finely granular débris which resembles the protoplasm of the cells.

The epithelium of the ascending loops of Henle occasionally shows similar degeneration and necrosis, and bile pigment is present in some of the cells.

There is much desquamation of the cells of the second convoluted tubules and small collecting tubules; the cells are well defined and brightly stained, so that they contrast sharply with those of the first convoluted tubules. In some of the cells of the second convoluted tubules there are small fatty granules which are stained by sudan and give a pink reaction in Nile-blue. The tubules contain masses of homogeneous and granular, occasionally deeply eosinophil, substance.

In some of the large collecting and discharging tubules there are

homogeneous and granular casts. The casts in the second convoluted, large collecting and discharging tubules are Gram-positive. Iron-pigment is not demonstrated by the Turnbull's blue method.

There is no evidence of inflammatory reaction on the part of the cells of the blood or fixed tissues.

The spleen. The red corpuscles are laked, except in the narrow external zone, in which complete fixation was noted on macroscopic examination. The laking is, therefore, evidently due to improper fixation. There is much precipitation of formalin-pigment.

There is no abnormality in the structure of the capsule, trabeculae, arterioles or veins.

The Malpighian bodies are numerous and of considerable size. They have no 'Germ centres.' They contain in addition to lymphocytes an increased number of cells which, in default of any generally accepted name, will be referred to here as 'free endothelial cells.' These cells are approximately round and occupy an area equal to from three to four and a half red corpuscles. The protoplasm is non-granular and basophil. The nucleus occupies half or more of the cell. The chromatin is arranged as a, usually wide-meshed, net of narrow rods, and is also massed as a stout capsule round each of the three or four large nucleoli. The sharply defined nuclear membrane and the chromatin are deeply stained and contrast with the pale nucleoplasm.

The pulp is greatly engorged. The pulp strands between the capillary veins are narrow, and the fibrils and fixed cells of the reticulum thereof are not increased. There are many free cells in the pulp in addition to the red corpuscles. The free cells lie both in the pulp strands and in the capillary veins, especially in the latter. Among the free cells there are numerous 'free endothelial cells' such as have been described above. Many show karyokinetic figures. There are several giant cells which have two to seven large oval nuclei occupying almost the whole of their non-granular, basophil protoplasm. Where several nuclei are present they are superimposed. Some of these large cells have a single, ribbon-like, deeply stained nucleus, and suggest megakaryocytes. The protoplasm, however, in Jenner's stain is more basophil than that of the megakaryocytes of marrow. The giant cells

appear to be multinuclear derivatives of the 'free endothelial cells.' Large and small lymphocytes are numerous; neutrophil leucocytes are relatively few in number. There are a very few necrosed, swollen vacuolated cells. Eosinophil leucocytes, plasma cells and myelocytes were not found.

There is a considerable number of coarse granules of iron pigment (Turnbull's blue) in the spleen. The granules are usually intracellular.

Granules of fat were not found in any of the cells in sections stained by sudan.

There are no organisms in sections stained by the methods of Twort or Weigert-Gram.

Stomach. A. In a section taken near the pyloric extremity of the portion of stomach the glands are lined by 'chief cells' and 'parietal cells'; the latter are very abundant. The 'chief cells' are rounded, granular or vesicular, and to a large extent desquamated. There is a little mucus in the cells lining the glandular crypts. The interglandular stroma is very scanty and is free from infiltration. There is engorgement of the veins and capillaries in the submucosa. In sections stained by sudan the parietal cells are stained diffusely, and some also contain a few brightly stained granules of fat.

B. In sections from the cardiac end, the mucosal glands contain parietal and chief cells. The latter are rounded, granular or vesicular and frequently desquamated. The capillaries in the submucosa and mucosa are greatly engorged. In the mucosa the engorgement is extreme, and there are extensive extravasations of blood. The epithelial lining of the tubules in most of the mucosa is separated widely from the intertubular stroma by oedema. The superficial third or more of the mucosa is necrosed in the areas of severe haemorrhage. The bundles of the muscularis are separated by oedema. There are some bacilli and cocci upon the surface of the mucosa.

[The following remarks on his examination of specimens in this case and that of Case L. 14 (p. 219) were appended by Dr. Turnbull to his report on the latter examination. They are inserted here for convenience.]

Summary and Analysis of Histological Abnormalities

Case L. 26 (pp. 45 and 196). The *liver* is the seat of a very severe parenchymatous degeneration and necrosis, in which an accumulation of fat is the most important feature and a hyaline alteration of the protoplasm is conspicuous. A narrow zone of hepatic cells immediately round the portal systems is almost intact, the external half of the remainder of the lobule is much more severely affected than the central. The degenerate and necrosed cells compress and appear to constrict to capillaries. There is icterus and an accumulation of granules of iron pigment. There is no evidence of inflammatory reaction except an infiltration of the portal systems, which in its cytology resembles the infiltration found in the spleen.

The *kidney* also is icteric and shows extensive necrosis and parenchymatous degeneration. Necrosis of the first convoluted tubules is extreme and dominates the picture. Fatty degeneration is slight, and is confined to the second convoluted tubules. Casts are present. There is no accumulation of iron pigment. There is no evidence of inflammatory reaction in the form of emigration of cells from the blood or proliferation of cells in the interstitial tissues.

The *spleen* is engorged and is the seat of a cellular infiltration of well-defined character. In this an increase in leucocytes takes very little, if any, share; the characteristic of the infiltration is a proliferation of 'free endothelial cells.' These cells are present in considerable numbers in the Malpighian bodies and are very numerous in the pulp. Giant and multinuclear examples are conspicuous. The occurrence of karyokineses bears witness to the activity of the proliferation. There is a considerable deposit of iron pigment in the spleen.

In the *stomach* there are engorgement, oedema, slight parenchymatous degeneration and, in the mucosa of the cardiac portion, most extensive haemorrhages which have led to necrosis. There is only a trace of fatty degeneration in the parenchyma, in some of the parietal cells. There is no inflammatory infiltration, nor proliferation of the interstitial tissue.

In the media of some of the *arteries* within the above organs there is a slight fatty degeneration.

Case L. 14 (p. 219). In the *liver* there is a slight portal fibrosis. The dense and sclerotic nature of the fibrous tissue excludes recent activity of the process; the fibrosis bears no constant relation to an infiltration which resembles that in Case L. 26 and which is only found in some of the portal systems. The slight portal fibrosis is evidently an accidental complication. The other histological changes differ from those in Case L. 26 in intensity alone. The degeneration and necrosis are greater, and the central portion of the lobules is as severely affected as the intermediate. There is a greater accumulation of iron pigment.

The changes in the *kidney* only differ in detail from those in Case L. 26. Necrosis of the parenchyma is much less marked, and there is a corresponding increase in the expressions of degeneration. Thus fatty degeneration is much more marked in the second convoluted tubules, and is found also in the loops of Henle and collecting tubules. Casts of albuminous, fibrinoid substances, especially a deeply eosinophil hyaline substance, are very numerous. As in Case I, there is no evidence of inflammatory reaction, so that the term 'nephritis' is not justified.

In the *spleen* the pathological condition is essentially similar to that in Case L. 26. The proliferation of the 'free endothelial cells' in the Malpighian bodies is much greater, and has led to a decrease in their lymphocytic content; the bodies appear, therefore, smaller, and their borders are ill-defined. In the pulp there are very large numbers of the free endothelial cells, but they have almost all become vacuolar, often necrosed, phagocytes.

In the *small intestine* there are congestion, a general infiltration of the mucosa and focal necroses in the mucosa. The general infiltration of the mucosa, and especially the numbers of neutrophil leucocytes therein, are evidence of inflammation. The focal nature of the necroses of the mucosa points to their having occurred before death; the absence, however, of any zone of inflammatory reaction round them indicates that they were agonal.

In the *lung* there is extensive extravasation of blood. The alterations, however, in this blood, the general pyknosis of nuclei, and the eosinophilia and yellow discoloration of the tissue, in conjunction with the masses of bacteria of different kinds in the air passages, form a picture which is characteristic of haemorrhage due

to acid digestion from agonal aspiration of stomach contents. Such agonal, acid digestion is so commonly associated with cases in which there has been vomiting during life, for instance peritonitis, that its presence in this case may perhaps be regarded as slight evidence of a disease associated with vomiting.

Clumps of *bacteria* are present in the liver, kidney, small intestine and lung in Case L. 14. Their great variety and their absence from Case L. 26 exclude their being the causal factor of the histological changes. The absence of any reaction round the masses points to the infection being agonal. As regards their source, reasons have been given for supposing those in the lung to have been inspired with stomach contents. Those in the necrosed mucosa of the intestine are similar to the bacteria usually found within the intestine, and have doubtless been derived from the intestinal lumen. The morphological characters of those in the liver and kidney also point to the intestinal wall as the portal of infection.

Significance of the Differences in the Two Cases

Death appears to have occurred at an earlier stage of the disease in Case L. 26, and the earlier onset of death was perhaps due to the rapid and extensive necrosis of the kidney. Thus in Case L. 14 the affection of the liver is severer, and when compared with Case L. 26 appears to have advanced towards the central veins. In the kidney degenerations are much more conspicuous, and there are greater accumulations of casts; the parenchymatous degeneration appears to have had longer time to develop. In the spleen the proliferation of endothelial cells is greater and the cells have become phagocytes.

Comparison with the lesions of Yellow Fever described in the literature

The general features of the pathological changes in yellow fever, as described in the literature to which I have had access (vide infra), are found in the two cases under discussion. These general features are:—Icterus. Severe parenchymatous degeneration and necrosis of the liver, in which fatty degeneration plays the most

conspicuous rôle. A variable degree of parenchymatous degeneration and necrosis of the kidney; in which fatty degeneration may be very slight. Engorgement and haemorrhage in the intestine, the haemorrhage being greatest and usually very conspicuous in the stomach. A variable degree of inflammation and necrosis of the mucosa of the intestine. Engorgement of the pulp of the spleen. No constant, nor characteristic change in the lung.

Further, such details as are given in the descriptions of the histological changes are almost all found in the two cases under discussion. Thus in the liver, Carroll (1905) describes a zone of cells round the portal systems in which degenerative changes are slight. He specially mentions a hyaline, deeply eosinophil, necrosis of the hepatic cells. Marchoux and Simond (1906) describe compression of the capillaries by swollen hepatic cells in cases in which death occurs between the fifth and tenth day. Carroll says that this compression is so constant and peculiar a feature that it can indeed be considered as characteristic of the disease. It may, however, be found in other diseases.

The microscopic pictures of the kidneys in Cases L. 26 and L. 14 are to be found in those enumerated by Carroll.

I can find no description of the cytological changes in the spleen in yellow fever. All authors mention congestion. Marchoux and Simond say that the Malpighian bodies are reduced in volume and appear dissociated (cf. Case L. 14, p. 220).

In the mucosa of the stomach Marchoux and Simond found fatty degeneration in the parietal cells alone.

In the intestine, the same researchers found no fatty degeneration of the epithelium of the glands (others, however, quoted by Otto, are said to contradict this). Marchoux and Simond lay stress on a separation of the epithelium from the villi of the small intestine by oedema, similar to that present in the stomach of Case L. 26.

The occasional presence of masses of bacteria in the organs is described. Thus Carroll mentions it as a phenomenon in the kidney, and ascribes it to secondary infection from the intestine.

The only detail mentioned which was not observed in Cases L. 26 and L. 14 is fatty degeneration of the endothelium. Stress is laid by Marchoux and Simond on the occurrence of this in the liver and spleen. Some fat was certainly found in the phagocytic endothelial cells in the spleen of Case L. 14; a little fat was also

found in the media of arteries in different organs. In this connection it must be remembered that the tissue of Cases L. 26 and L. 14 had been preserved in a 90 per cent. solution of alcohol.

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OTTO, M. (1907). Gelbfieber in Kolle und Wassermann's 'Handbuch der pathogenen Mikroorganismen.' Ergänzungsband II, 1, Jena, pp. 153-230 (p. 206).

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FIG. 1. Forcados. A main road.

The photograph illustrates (I) the manner in which the roads are raised above the general swamp level; (II) a tidal ditch.

It is by means of an intersecting system of such ditches that the swamp is drained.

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FIG. 2. Forcados. Native hospital and swamp—wet season.

FIG. 3. Forcados. Native hospital on right. Isolation block on extreme left. The swamp shewn in Fig. 2 is here seen on the left. Tidal ditches are seen on either side of the road.

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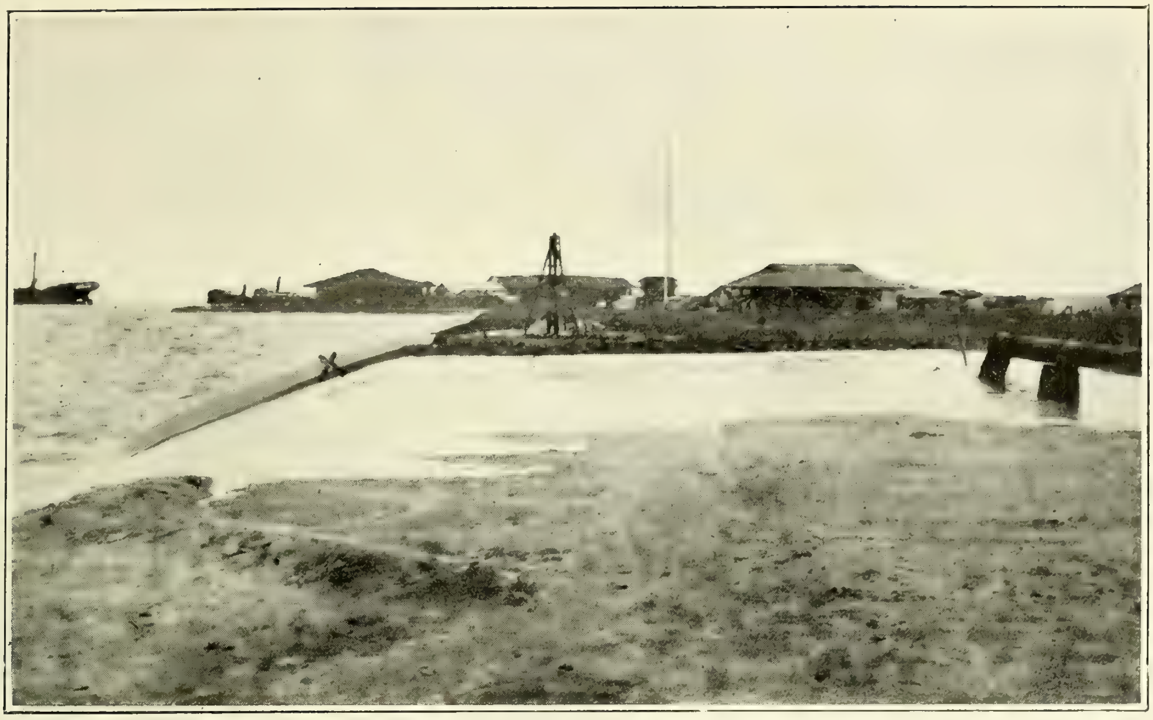

FIG. 4. Forcados. Illustrating the system of swamp reclamation. On the right is seen the pipe through which sand is being pumped from the sea. The water pumped up with the sand, drains back into the sea, encroachment from which is prevented by the concrete wall (x).

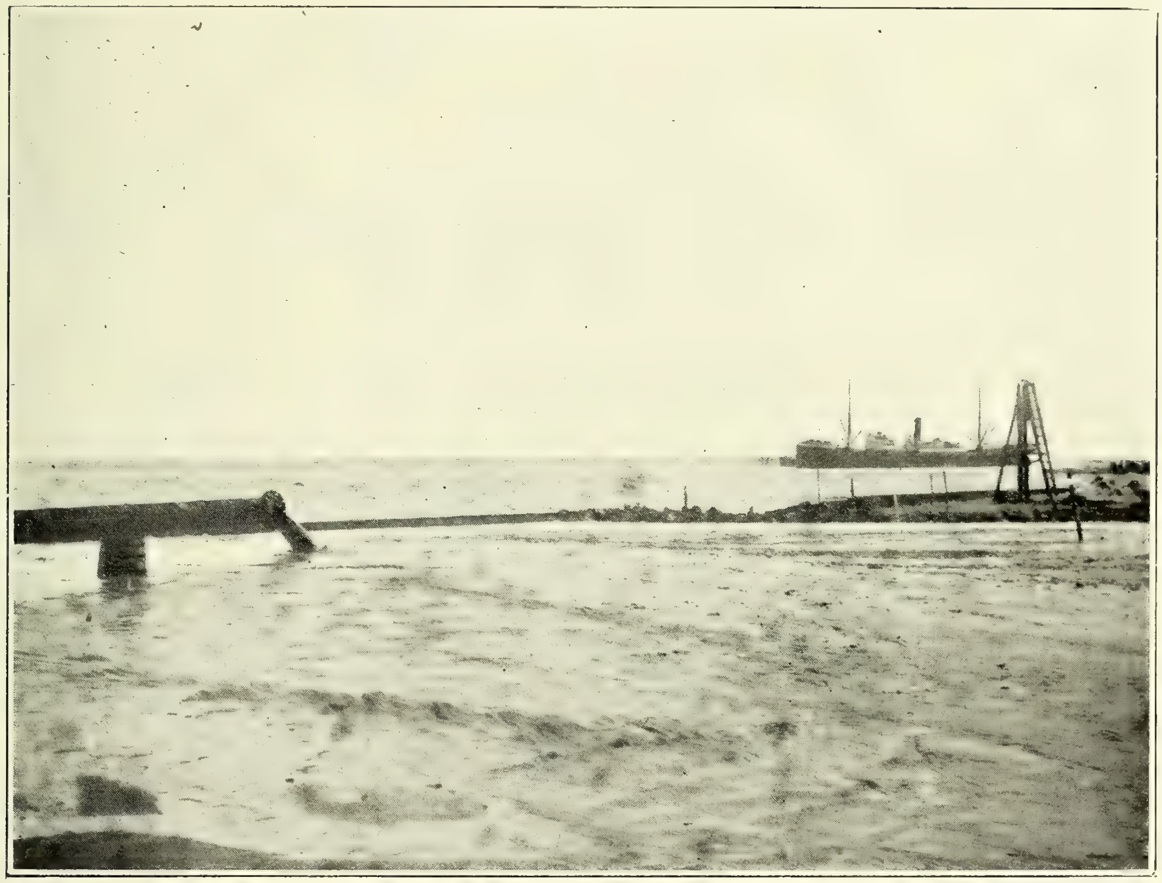

FIG. 5. Forcados. The same as Fig. 4 but seen from a different aspect.

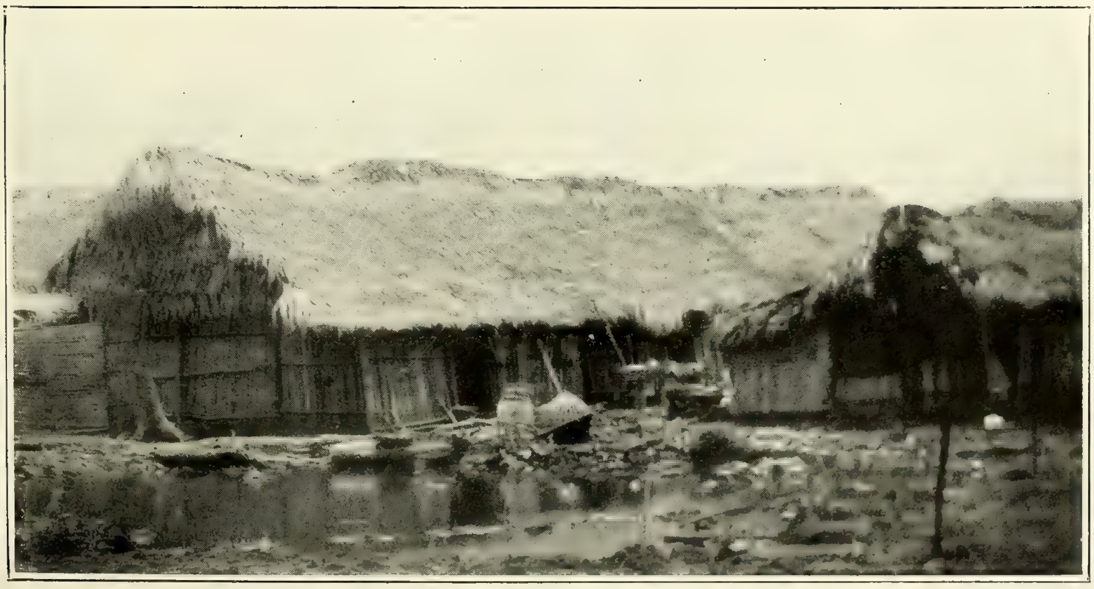

FIG. 6. Forcados. A native hut, built of reeds.

FIG. 7. Forcados. Government artizans' and clerks' quarters, built upon reclaimed swamp, shewing how the occupants exclude ventilation by mats and canvas.

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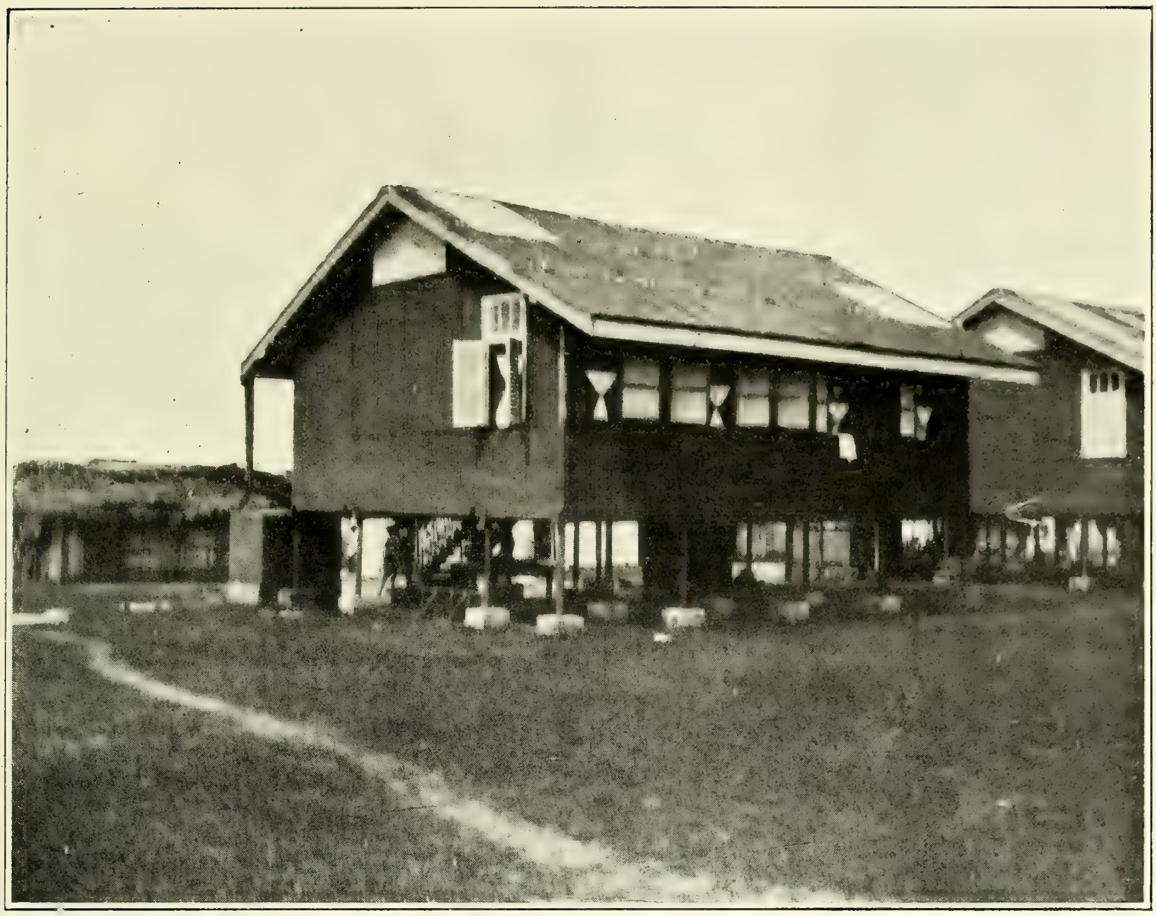

Fig. 8. Forcados. A native official's house, built upon piles, on reclaimed swamp. On the left is seen the kitchen, built of reeds.

Fig. 9. Forcados. Mosquito-proof bungalow for European official.

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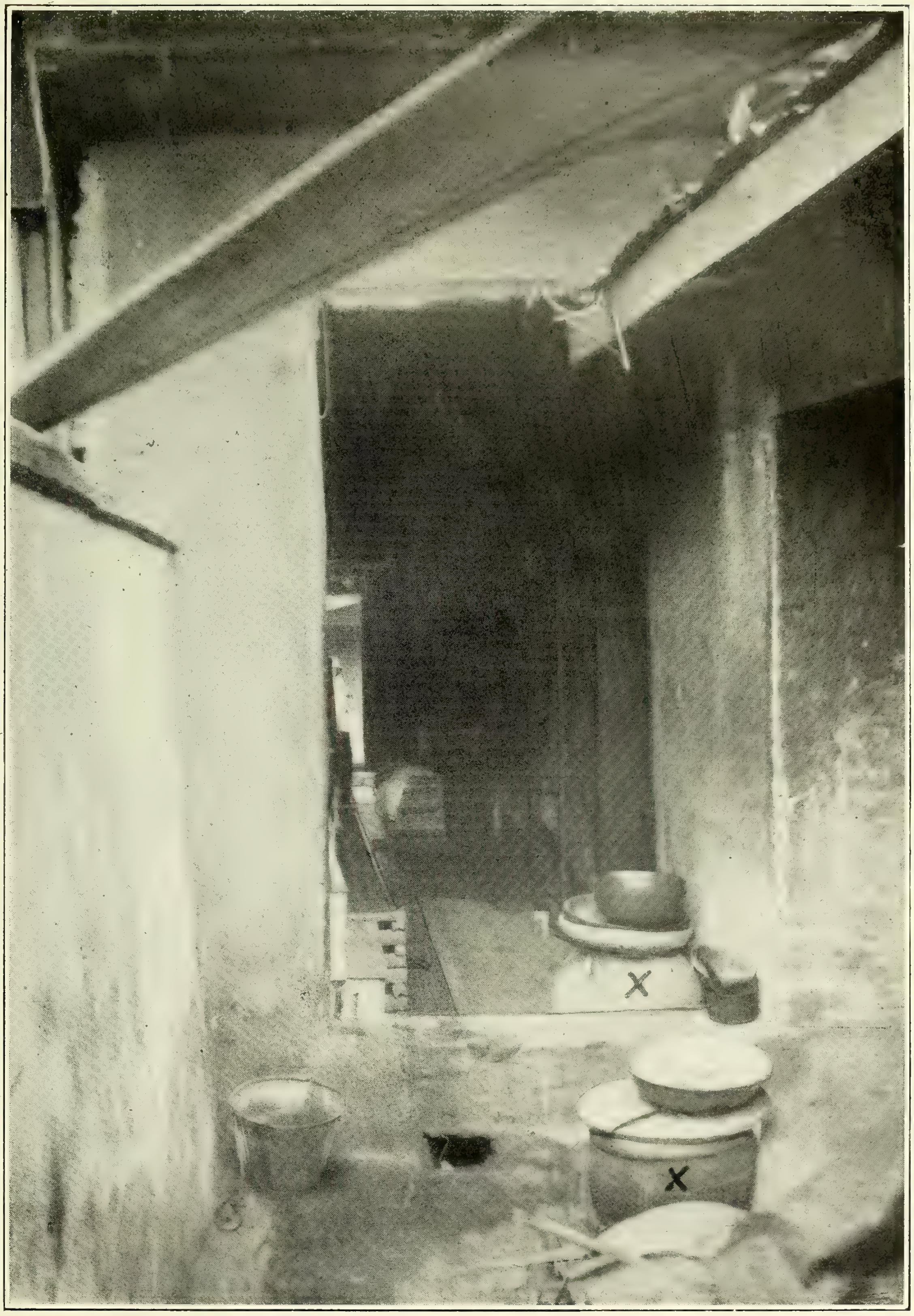

FIG. 10. Earthenware water-pots—a favourite breeding place of domestic mosquitoes.

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Fig. 11. Meko (Report I). Illustrating the manner in which water is carried. Mosquitoes breed freely in the calabashes shewn.

Fig. 12. Meko (Report I). The outer aspect of a native house which forms one side of a quadrilateral compound.

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PLAN OF

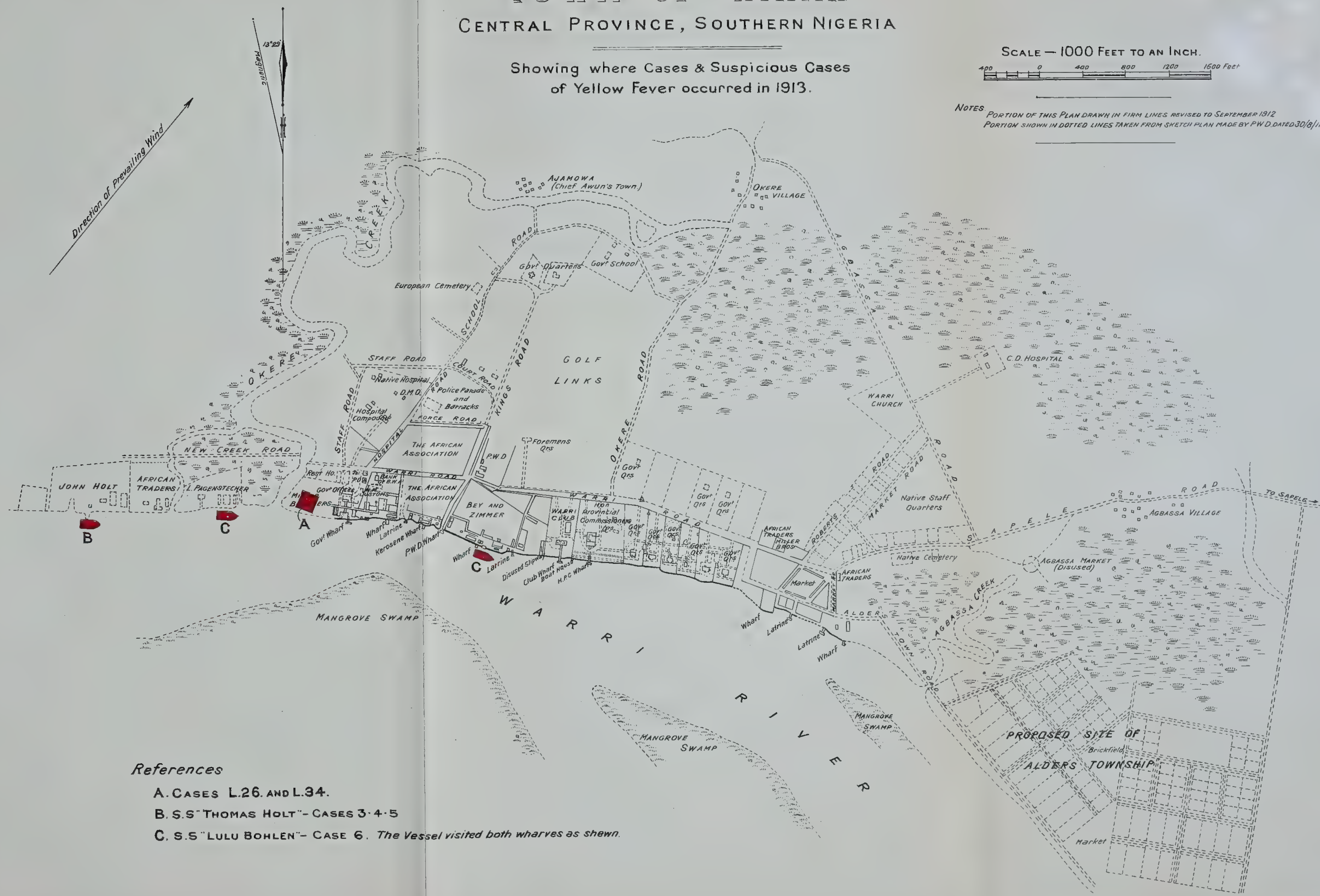
TOWN OF WARRI

CENTRAL PROVINCE, SOUTHERN NIGERIA

Showing where Cases & Suspicious Cases of Yellow Fever occurred in 1913.

SCALE — 1000 FEET TO AN INCH.

NOTES PORTION OF THIS PLAN DRAWN IN FIRM LINES REVISED TO SEPTEMBER 1912
PORTION SHOWN IN DOTTED LINES TAKEN FROM SKETCH PLAN MADE BY P.W.D. DATED 30/8/11



References

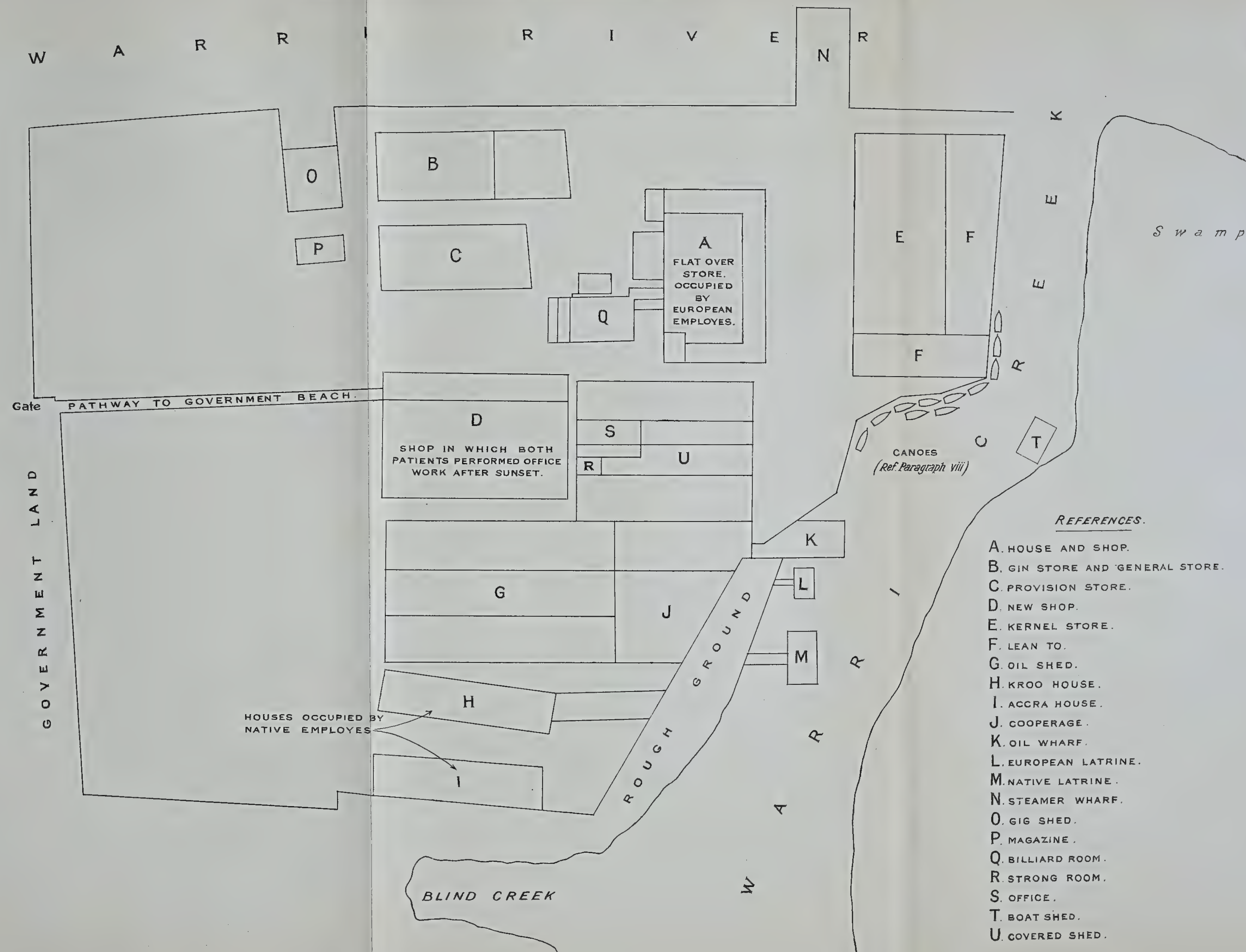
A. CASES L.26. AND L.34.

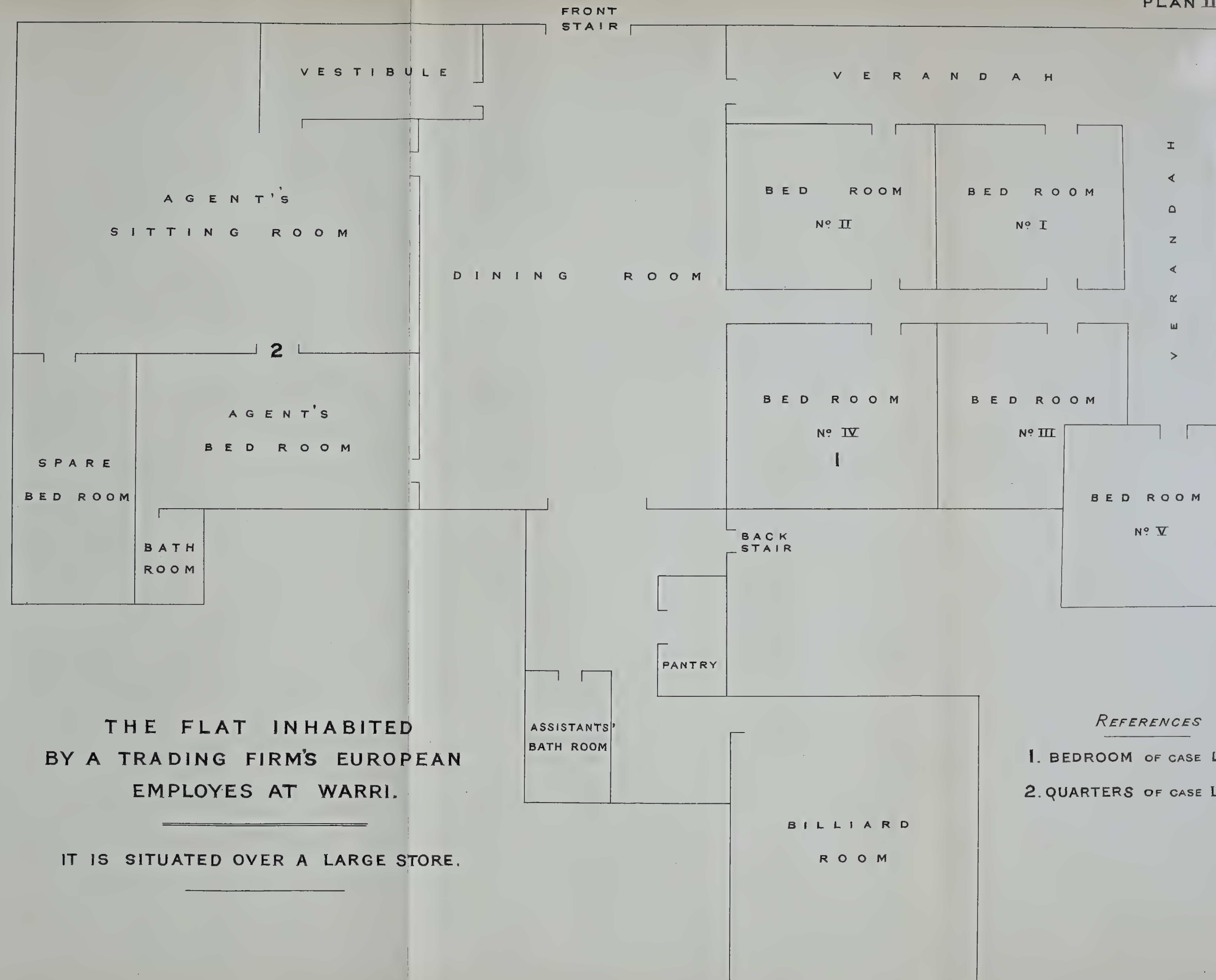
B. S.S "THOMAS HOLT" - CASES 3·4·5

C. S.S "LULU BOHLEN" - CASE 6. *The Vessel visited both wharves as shewn.*

PLAN I.

A TRADING FIRM'S COMPOUND, WARRI.



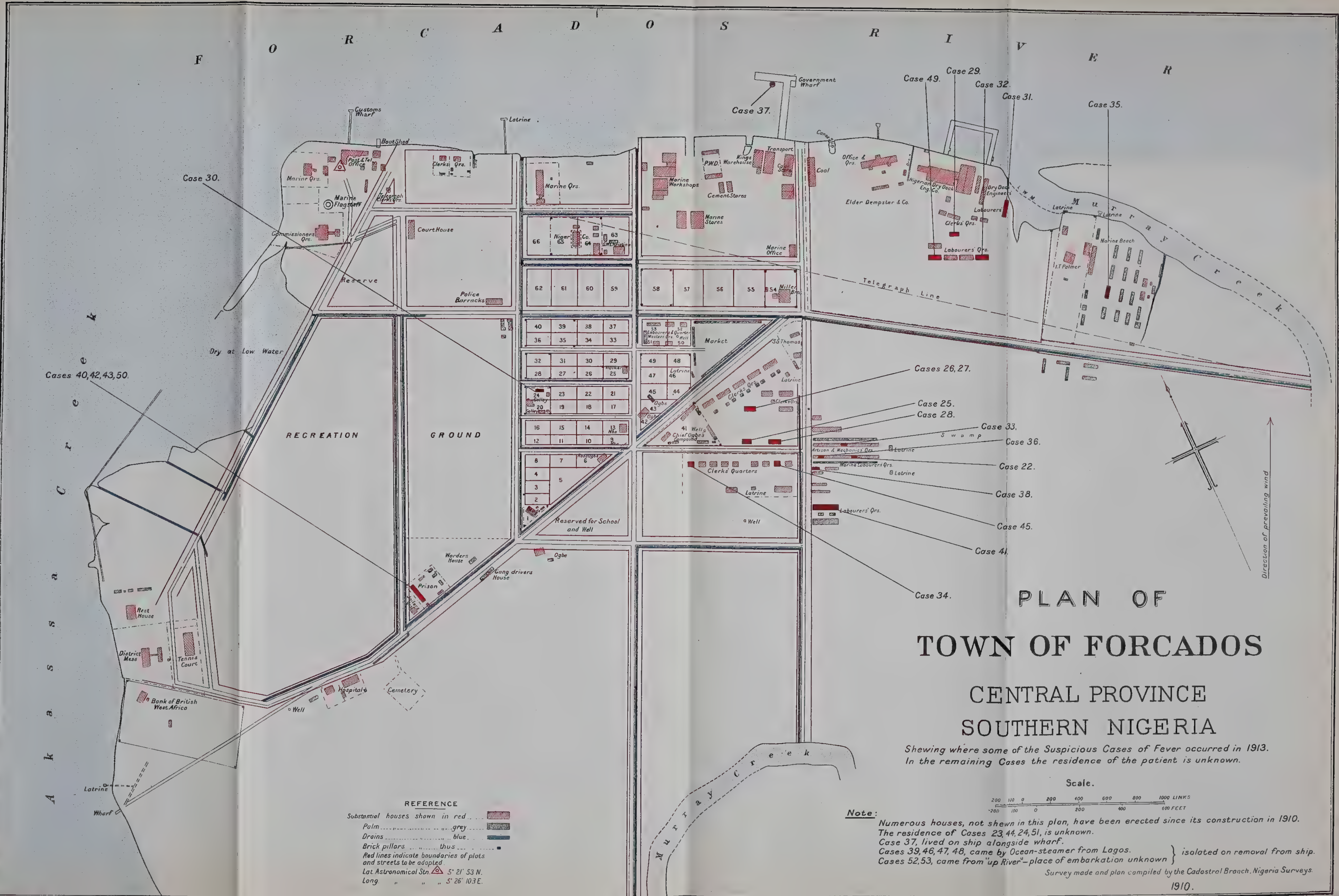


THE FLAT INHABITED BY A TRADING FIRM'S EUROPEAN EMPLOYES AT WARRI.

IT IS SITUATED OVER A LARGE STORE.

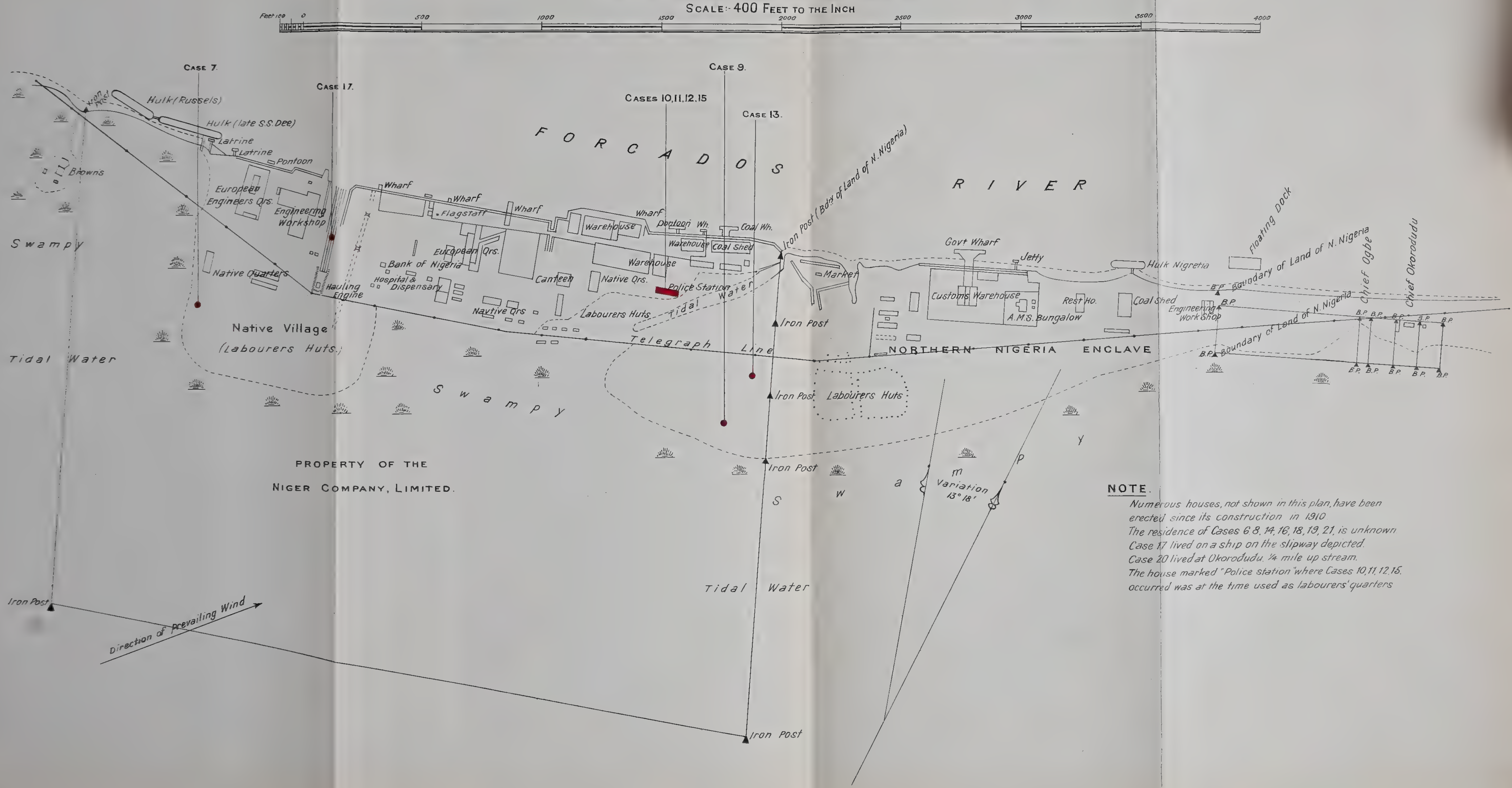
References

1. BEDROOM OF CASE L.26.
2. QUARTERS OF CASE L.34.


PLAN OF
TOWN OF FORCADOS
CENTRAL PROVINCE
SOUTHERN NIGERIA
Shewing where some of the Suspicious Cases of Fever occurred in 1913.
In the remaining Cases the residence of the patient is unknown.
Scale.
200 100 0 200 400 600 800 1000 LINKS
200 100 0 200 400 600 FEET
Note:
Numerous houses, not shewn in this plan, have been erected since its construction in 1910.
The residence of Cases 23, 44, 24, 51, is unknown.
Case 37, lived on ship alongside wharf.
Cases 39, 46, 47, 48, came by Ocean-steamer from Lagos.
Cases 52, 53, came from "up River"—place of embarkation unknown
isolated on removal from ship.
Survey made and plan compiled by the Cadastral Branch, Nigeria Surveys.
1910.
REFERENCE
Substantial houses shown in red
Palm " " grey
Drains " " blue
Brick pillars " thus
Red lines indicate boundaries of plots and streets to be adopted.
Lat. Astronomical Stn. 5° 21′ 53 N.
Long. " " " 5° 26′ 10.3 E.
FORCADOS RIVER
Akassa Creek
Murray Creek
Dry at Low Water
RECREATION GROUND
Reserve
Reserved for School and Well
Market
Swamp
Telegraph Line
Direction of prevailing wind
Customs Wharf
Government Wharf
Boat Shed
Latrine
Post & Tel. Office
Marine Qrs.
Marine Flagstaff
Commissioners Qrs.
Court House
Police Barracks
Marine Workshops
Cement Stores
Marine Stores
Marine Office
Kings Warehouse
P.W.D.
Transport
Coal
Office & Qrs.
Elder Dempster & Co.
Nigerian Dry Dock Eng. Co.
Dry Dock Engineers
Labourers
Clerks' Qrs.
Labourers' Qrs.
Marine Beach
Niger Co.
Clerks' Quarters
Chief Ogbe's Compound
Marine Labourers Qrs.
Warders House
Gang drivers House
Prison
Ogbe
Well
Rest House
District Mess
Tennis Court
Bank of British West Africa
Hospital
Cemetery
Wharf
Case 30.
Cases 40, 42, 43, 50.
Case 37.
Case 49.
Case 29.
Case 32.
Case 31.
Case 35.
Cases 26, 27.
Case 25.
Case 28.
Case 33.
Case 36.
Case 22.
Case 38.
Case 45.
Case 41.
Case 34.

PLAN OF BURUTU.

Showing where some of the Suspicious Cases of Yellow Fever occurred in 1913. In the remaining Cases the residence of the patient is unknown



Stanford's Geog^l. Estab^t. London.

REPORT ON CERTAIN OUTBREAKS OF YELLOW FEVER IN LAGOS, 1913, AND JANUARY AND FEBRUARY, 1914,

BY

T. M. RUSSELL LEONARD, L.R.C.S., L.R.C.P. (Edin.), L.F.P.S. (Glas.); *West African Medical Staff, Resident Medical Officer, Lagos Hospital.*

CONTENTS

APPENDICES

MAP

Plan map of Lagos showing areas in which the cases have occurred, also the declared areas under the Quarantine Regulations.

REPORT ON CERTAIN OUTBREAKS OF YELLOW FEVER IN LAGOS, 1913

In 1910 yellow fever occurred in a series of independent outbreaks in West Africa, viz., in Sierra Leone and on the Gold Coast, the first case from Sierra Leone being reported on the 15th May, and from the Gold Coast in April of that year. At Lagos, in Nigeria, there were two suspicious and rapidly fatal cases in natives; these were not reported as yellow fever, but from the clinical and post-mortem appearances were very probably cases of true yellow fever.

On the 12th May, 1913, the first authentic case of yellow fever in Nigeria was reported from Lagos Hospital by the Resident

Medical Officer. The diagnosis, which was definite, was confirmed by the post-mortem examination on the 15th, the case terminating fatally on the 14th May. This case is of great interest and importance, as the patient had arrived from Abeokuta, an inland native town about 60 miles from Lagos, on the afternoon of the 10th, and complained of being ill that night. He was seen by a medical man on Sunday, the 11th May, and was sent to the Lagos Hospital on the 12th, where the diagnosis was made. The previous history of this case, with the result of inquiries made at Abeokuta, has been already given by Dr. Wyler in his first report. The infection had, without any doubt, been incurred at Abeokuta and not in Lagos, as the patient had not been in Lagos prior to his illness, but had resided for sixteen months in Abeokuta and six months in Illorin, still further inland. No cases of yellow fever had ever before been reported from Abeokuta, or, in fact, from Lagos, except that in 1910 two rapidly fatal cases were considered suspicious of the disease. As soon as this case was reported to the Principal Medical Officer and Senior Sanitary Officer immediate steps were taken, and the premises occupied by the patient prior to his admission to hospital were at once fumigated. The other inmates, European and native servants and employés, were removed and put under close observation for a period of five days. No other cases occurred among these contacts. On the 14th of May, a case (No. 2) of fever was admitted to the hospital and diagnosed as extremely suspicious of mild yellow fever. The patient was a native tailor, residing in Bangbose Street, a considerable distance from the premises where the first case of yellow fever had occurred. The symptoms were well marked, and the Senior Sanitary Officer, on the case being reported to him, took immediate action and had the house fumigated. The next case (No. 3) was a labourer working at the Customs and residing in Custom Street, who was admitted into hospital on the 15th May. The symptoms in this case were also very suspicious of yellow fever. The premises in which he resided were also thoroughly fumigated. The fourth case came into hospital on the 16th May with well-marked symptoms of yellow fever of a mild type. He was a Sanitary Inspector residing in Apongbon Street, who had been employed in the fumigation of the premises in which Case No. 1 had occurred. His

house was similarly dealt with and fumigated. Case No. 5 was a native labourer working and residing at Apapa on the mainland, who was admitted into hospital on the 26th May. No quarantine was declared at this time as these four native cases were regarded as suspicious only, the houses that they occupied being thoroughly fumigated. On the accompanying map of Lagos, these cases are shown marked in blue, and their significance can be appreciated when seen in conjunction with the infected areas of the next two epidemics that occurred later in the year.

On the 28th May, a German engineer from the s.s. 'Epe,' of the Woermann Linie, was admitted into hospital suffering from fever. Blood examination showed the presence of malaria parasites, but in the course of his illness he developed symptoms that undoubtedly pointed to an infection of yellow fever as well as malaria. The vessel was fumigated and the crew kept under observation.

From the 28th of May to the 17th July there was a lull, no cases of fever of a suspicious nature being reported or admitted into hospital, nor were any seen at any of the dispensaries, although great care and vigilance were exercised by the Medical Officers. On the 17th of July, a European employé of the Bank of British West Africa was admitted into hospital late at night and a diagnosis of yellow fever of a virulent type was made, and the case reported to the Principal Medical Officer and sanitary authorities. The case terminated fatally on the 20th July, and the post-mortem examination confirmed the diagnosis made on admission. The Bank premises were closed and thoroughly fumigated, all the inmates were removed to the isolation hospital and kept under close observation for a period of five days. The houses in the immediate vicinity were also fumigated and the inmates put under surveillance for five days. This case was rapidly followed by others. The next case, a Syrian male, was admitted into hospital on the 19th July from a house in Labrinjon Lane close to the Bank premises. This case was also a virulent type of yellow fever, and death occurred on the 22nd July. Quarantine was declared by the Governor in Council and the Port of Lagos put under the strictest regulations. The areas marked 1 and 2 on the accompanying map were declared infected areas, and the inhabitants removed and put under surveillance. The contacts were sent to the isolation

hospital, and the houses in the areas were closed up and properly fumigated. Other cases rapidly followed, the next (No. 10) being a native who had resided in Labrinjon Lane and who was trying to leave Lagos, but was stopped at the railway station at Iddo by the Medical Officer inspecting all the trains and passengers. Two Syrian contacts, male and female, who had been removed to the isolation hospital from the premises in which Case No. 8 had occurred developed the disease while there and were sent to the Lagos hospital for treatment. The female, Case No. 9, was admitted on the 20th and made a complete recovery, being discharged cured on the 12th August. The male, Case No. 11, was admitted into hospital on the 25th and died on the 28th July.

Cases of yellow fever continued to come into hospital during the months of July and August from various areas of the town, one case (No. 16) being taken off the s.s. 'Delta,' a branch boat of Messrs. Elder Dempster and Company, lying off the wharf at Iddo, on the mainland. This vessel was claytonized, and the crew were put under observation and surveillance for the usual quarantine period.

Case No. 21 was taken off the passenger train from Ibadan by the Medical Officer inspecting all the trains coming to and leaving Lagos. This man had come from Ogbomosho, an inland town, *viâ* Ibadan, and had not been in Lagos before. The results of inquiries made as to his previous movements, and the possibility of the infection being incurred at Ogbomosho, have been dealt with by Dr. Wyler in his early reports. The last case of this outbreak was admitted into hospital on the 29th of August and discharged cured on the 22nd September, and, as no further cases occurred, quarantine was raised on the 22nd.

An interval of twenty-three days, viz., from the 1st to the 23rd of September, elapsed, and no fresh cases of the disease occurred, but on the 24th the next case, No. 24, was admitted into hospital. The patient was a clerk residing in Apongbon Street, in the area where a previous case (No. 17) had occurred on the 5th August. This area had been declared and dealt with by the sanitary authorities on that date. The patient made a complete recovery and was discharged on the 8th October.

The next case (No. 25) a barber, who resided in Kakawa Street,

near the premises of the Bank of British West Africa, was admitted on the 3rd October. Quarantine was again declared and the two areas declared infected. The inhabitants were removed, and the inmates of the infected houses were sent to the isolation hospital, the others being put under surveillance for the usual quarantine period.

A police constable residing at Apapa, on the mainland, was the next case (No. 26) to be admitted to hospital with a severe attack of yellow fever. This area was also closed and the inhabitants were put under strict surveillance. The patient was admitted on the 11th of October and discharged cured on the 6th of November.

On the 17th of October, a police constable who had arrived on the 16th from Forcados with prisoners reported sick and on admission was found to be suffering from yellow fever. This infection had undoubtedly been contracted at Forcados prior to his arrival in Lagos. The constable had stayed at Forcados for seven days, having come with the convicts from Onitsha. The station in Lagos in which he had resided on his arrival was fumigated, the area declared infected, and the residents placed under observation.

On the 18th of October the next European case was admitted into the Lagos hospital (No. 28). He came from Wilberforce House, the premises from which the first authentic case of yellow fever had come. This case was a mild type of the disease, and made an uneventful recovery, being discharged cured on the 3rd November. No further cases occurring in Lagos during the period, quarantine was removed.

The cases that now follow are all Europeans and all occurred on various ships; the infection in all the cases having been incurred outside Lagos, possibly Forcados or the Oil Rivers. In regard to one case, viz., Case No. 34, the question of infection in Lagos is a moot point.

The last four cases, viz., Nos. 35, 36, 37, 38, were not Lagos cases, but are included in this report to complete the list of cases occurring on vessels at ports in Nigeria.

With regard to Case No. 37 from the s.s. 'Elmina,' very few particulars could be obtained, but what there are, with the history of the illness and the temperature chart, point to its being a very suspicious case of fever.

On the 26th of October a medical man was sent for to visit the German ship, 'Elizabeth Brock,' which had arrived in Lagos on the 23rd from the Oil Rivers. This vessel had been given pratique, as the captain had informed the Port Officer that there were no cases of illness on the ship. The patient that the doctor had been summoned to see died before his arrival on board, so the body was brought to the hospital mortuary, and two other members of the crew who were found to have febrile temperatures were also brought ashore and admitted into hospital. These three men had been ill since the 24th October and were being treated by the captain of the ship. The post-mortem examination on the one who died showed the hospital in a state of delirium with a temperature of 106·8°. The other two men were found to be suffering from yellow fever, but made an uninterrupted recovery and were discharged cured on the 11th November. The vessel was taken out of the harbour, as the captain refused to have fumigation done.

On the 26th of November, an officer of the s.s. 'Bassa,' a branch boat of Messrs. Elder Dempster and Company, was sent into hospital in a state of delirium with a temperature of 106·8°. The vessel had come from Forcados, at which place the patient had first complained of being ill. The disease was of a very severe type and death occurred four hours after admission, with a temperature of 109°. No other cases occurred on board this vessel, which had been thoroughly fumigated when the case was reported.

On the 24th of December, a case of fever occurred on board the s.s. 'Montenegro,' lying at Iddo wharf. The patient died on the way to the hospital, and the post-mortem examination showed the cause of death to be yellow fever. This vessel had come out from England and had called at ports on the Gold Coast before arriving at Lagos, but as the vessel had been lying in Lagos for at least a week, the question of infection is a moot point.

On the 28th of December, Dr. Manson was called to see a case of fever on board the s.s. 'Nyanga,' and on his arrival on board found the patient, who was an officer of the ship, unconscious and moribund. The man died in his presence after an attack of convulsions. The history of the case was that the patient had complained of fever on the 25th December, from which date the temperature had remained persistently high until the day of his

death, when it reached 106°. He had suffered from vomiting and had brought up a black-looking fluid. The vessel had been at Bonny on the 17th, Calabar on the 18th, and at Oron on the 19th of December. She left Calabar on the 21st and arrived at Lagos on the 23rd of December, where she anchored off Wilmot Point, some 300 yards from the shore, but on the 26th left the lagoon and anchored outside the bar, in the Roads. The deceased officer had never been ashore in Lagos. The infection in this case was undoubtedly contracted outside Lagos, possibly at Bonny or Calabar.

Case No. 37, which I have included in this report, is, in my opinion, very suspicious of yellow fever. The history of the case is as follows:—The patient, an officer of a vessel, was taken ill on the 20th of October at Forcados. He was under treatment until the 23rd, when his condition became very serious, the temperature reaching 106°, and delirium being present. Death took place early in the morning of the 24th. Patient had been treated with quinine. No post-mortem examination was made. Cases Nos. 36 and 38 occurred on vessels outside Lagos. Case No. 36 occurred on board the s.s. 'Zaria' outside Forcados, and it is a point of great interest that a passenger from this vessel was transferred to the s.s. 'Elizabeth Brock' at Opobo, on the 6th October, both vessels then being at that place. Eighteen days later, viz., the 24th October, yellow fever occurred on board the s.s. 'Elizabeth Brock' on her arrival in Lagos. The fatal case on the s.s. 'Zaria' occurred on the 18th. The conclusion drawn from these facts is that the infection must have been incurred in the ports in the Oil Rivers.

Case No. 38 was reported from Calabar and occurred on board the s.s. 'Monrovia,' the patient being a fireman of that vessel. He was admitted into hospital on the 26th October with the symptoms of yellow fever well marked. He made a complete recovery. No other cases occurred on this vessel.

The above cases show that yellow fever undoubtedly exists in Lagos, and in the other seaport towns of the Colony, and that so far as has been demonstrated, none of the cases were new importations from another Colony. The conclusion to be inferred is either that yellow fever is, and has been, endemic in this Colony, and that its presence in the past has not been suspected, or that cases have

occurred and have been confused with the severer types of malarial fever met with on this coast. A double infection may, and very often does exist, of yellow fever and malarial fever, as is seen in many of the cases described in this report. There is no doubt that in the past the mere presence of the malaria parasites in the blood has often led to a diagnosis of malarial fever and the graver complication of yellow fever has been overlooked, especially if the pulse rate, the albuminuria (a symptom which is by no means a common one in simple malarial fever) and the post-mortem appearances, which in yellow fever are very definite, have been neglected, or if no post-mortem has been performed in cases with a fatal termination.

The blood of every case was not only examined at the Lagos hospital, but was sent to the Medical Research Institute at Yaba; films being made daily from the time the case was admitted until its discharge from hospital.

Specimens and smears from the various organs taken at the post-mortem examinations of the cases with a fatal termination were also sent to the Research Institute.

A table of all the cases is appended, together with a full clinical report of each case in the order of its occurrence, with temperature charts and a synopsis of the various symptoms, blood-examinations, post-mortem examinations and laboratory reports.

Appendices A, B, C, D conclude the report, with a map of Lagos showing the areas in which the cases occurred.

Tabular Statement of Cases

Place	Case No.	Com-mission No.	Race	Age	Occupation	Date	Result	Quinine Prophylaxis	Malaria Parasites	Remarks
Lagos ...	1	L.14	European	28	Trader	May 12—14 ...	Death	Regular	Absent	Imported case from Abeokuta.
,,	2	L.23	Negro	25	Tailor	May 14—31 ...	Recovery	Nil	,,	—
,,	3	L.25	,,	29	Labourer	May 15—30 ...	,,	,,	,,	—
,,	4	L.24	,,	22	Sanitary Inspector	May 16—30 ...	,,	,,	,,	—
,,	5	L.35	,,	26	Mechanic	May 26—June 12 ...	,,	,,	,,	—
,,	6	L.36	European	21	Engineer	May 28—June 24 ...	,,	,,	Present	—
,,	7	L.37	,,	34	Accountant	July 16—20	Death	Regular	Absent	—
,,	8	L.38	Syrian	40	Clerk	July 18—22	,,	Nil	,,	—
,,	9	L.39	,,	24	Trader	July 20—Aug. 12 ...	Recovery	,,	,,	—
,,	10	L.40	Negro	29	Labourer	July 18—Aug. 12 ...	,,	,,	Present	—
,,	11	L.41	Syrian	35	Trader	July 24—28	Death	,,	Absent	—
,,	12	L.42	Negro	26	Servant	July 25—Aug. 12 ...	Recovery	,,	,,	—
,,	13	L.43	,,	36	Police-constable	July 22—Aug. 18 ...	,,	,,	Present	—
,,	14	L.44	European	30	Accountant	July 25—Aug. 12 ...	,,	Regular	Absent	—
,,	15	L.45	Negro	23	Servant	July 27—Aug. 12 ...	,,	Nil	Present	—
,,	16	L.46	,,	26	Cook, s.s. 'Delta'	July 27—Aug. 18 ...	,,	,,	Absent	—
,,	17	L.47	,,	39	Clerk	Aug. 3—14	,,	Irregular	Present	—
,,	18	L.51	,,	21	Labourer	Aug. 10—26... ...	,,	Nil	Absent	—
,,	19	L.52	,,	20	Servant	Aug. 12—26... ...	,,	,,	,,	—
,,	20	L.53	,,	38	Quartermaster, s.y. 'Ivy' ...	Aug. 14—27... ...	,,	,,	Present	—
,,	21	L.55	,,	29	Trader	Aug. 22—Sept. 7 ...	,,	,,	,,	Ogbomosho case.
,,	22	L.56	,,	27	Police-constable	Aug. 26—Sept. 9 ...	,,	,,	Absent	—
,,	23	L.63	,,	22	Labourer	Aug. 28—Sept. 22 ...	,,	,,	Present	—
,,	24	L.64	,,	27	Clerk	Sept. 19—Oct. 8 ...	,,	,,	,,	—
,,	25	L.69	,,	21	Barber	Sept. 30—Oct. 14 ...	,,	,,	Absent	—
,,	26	L.73	,,	36	Police-constable	Oct. 11—Nov. 6 ...	,,	,,	Present	—
,,	27	L.90	,,	29	Police-constable	Oct. 17—Nov. 12 ...	,,	,,	,,	Forcados case.
,,	28	L.91	European	21	Trader	Oct. 16—Nov. 3 ...	,,	Irregular	Absent	—
,,	29	L.102	,,	21	Steward, s.s. 'Elizabeth Brock'	Oct. 23—26	Death	,,	,,	Imported case.
,,	30	L.103	,,	20	Fireman, s.s. 'Elizabeth Brock'	Oct. 24—Nov. 11 ...	Recovery	,,	,,	Oil Rivers.
,,	31	L.104	,,	37	Fireman, s.s. 'Elizabeth Brock'	Oct. 24—Nov. 11 ...	,,	,,	Present	—
,,	32	L.105	,,	27	— s.s. 'Bassa'	Nov. 26	Death	,,	,,	Forcados case.
,,	33	L.106	,,	38	Engineer, s.s. 'Baro'	Nov. 25—Dec. 4 ...	Recovery	,,	Absent	Forcados infection.
,,	34	L.107	,,	41	Steward, s.s. 'Montenegro' ...	Dec. 24	Death	,,	,,	—
,,	35	L.119	,,	25	Officer, s.s. 'Nyanga'	Dec. 25—28 ...	,,	,,	,,	Oron infection.
Forcados	36	L.113	,,	32	Officer, s.s. 'Zaria'	Oct. 9—18	,,	,,	,,	Oil Rivers infection.
Lagos ...	37	—	,,	—	Officer, s.s. 'Elmina'	Oct. 20—23	,,	,,	,,	Forcados infection.
Calabar ...	38	—	,,	21	Fireman, s.s. 'Monrovia' ...	Oct. 26—Nov. 15 ...	Recovery	Nil	,,	—

CASE NO. 1. L. 14

Age: 28 years.
Sex: Male.
Nationality: British.
Occupation: Assistant to a trading firm.
Date of admission: 12th May, 1913.
Date of death: 14th May, 1913.
Diagnosis: Yellow fever.

History.—Patient has been in Nigeria for 22 months, 6 months at Illorin, and 16 at Abeokuta. Has suffered from gastric attacks during this tour, but has had no fever and takes quinine more or less regularly. He came to Lagos on the 10th instant, from Abeokuta for a change, as he had been feeling seedy for the previous three or four days. On the night of the 10th he complained of severe headache and pains in the eyes; his temperature was raised. He had a very restless night, with no sleep, and on the next day he was very much worse, with severe frontal headache, intolerance of light, and severe aches and pains all over the body. Noticed that his urine was very high-coloured and lessened in quantity. His temperature was 103°. He was seen by Dr. Gray that night, when his temperature was 104°. Had a restless night, severe headache, and general pains. On the morning of the 12th he was again seen by Dr. Gray and sent into hospital.

On admission.—Patient was admitted into hospital at 10.45 a.m. on the 12th. Temperature was 101·2°, with a pulse rate of 72. Complains of severe frontal and orbital headache, great intolerance of light. Face flushed, and the conjunctivae injected and shining. Lips and mouth very dry, and he complains of great thirst. Aching pains in the loins and extremities.

Alimentary system.—Tongue very red and pointed, tip and edges markedly so, dorsum coated. Liver is slightly enlarged, no tenderness. Spleen is normal, no tenderness. Epigastralgia present. Stomach very irritable, vomited twice after admission, vomit consisting of a pale greenish fluid with dark chocolate-coloured débris.

Circulatory system.—Pulse is slow, low tension, 72 per minute. Heart sounds are normal.

Respiratory system.—Respirations hurried, 24 per minute. Lungs normal.

Nervous system.—Severe frontal headache. Subsultus tendinum present. Aching pains in the loins and extremities.

Urinary system.—No urine has been passed since the morning, one ounce of urine was drawn off by catheter. Examination: Very cloudy and turbid. Acid reaction. Albumen present in large amount.

Blood examination.—No malaria parasites present. Leucopenia present. Differential count: Polymorphonuclear, 71 per cent.; mononuclear, 20 per cent.; lymphocytes, 4 per cent.; eosinophil, 5 per cent. Haemoglobin, 85 per cent.; blood pressure, 125.

At 2.50 p.m. Temperature was 102·4°, pulse rate 82, headache very severe. Bowels opened once, motion was dark green. Vomited again, greenish fluid with chocolate-coloured débris. Patient was very restless, and at 4 p.m. vomited again, vomit consisting of 6 ozs. of a dark brown liquid.

At 6 p.m. Temperature was 103°, pulse rate 80. Passed ½ oz. of urine, which was high-coloured, acid reaction, and contained albumen.

8 p.m. Temperature 103·2°, pulse rate 80. Bowels moved twice, 10 ozs. of dark green fluid with chocolate-coloured particles. No urine passed. Very restless.

10 p.m. Temperature 103°, pulse rate 84. Very restless and distressed.

Conjunctivae very injected. Vomited a small quantity of thick, dark brown fluid. Patient became quieter towards midnight and dozed a little. Bowels were again moved, motion similar to the previous ones.

13*th May*.—2 a.m. Temperature 101·6°, pulse 78. Very restless and complained of great discomfort in the epigastrium, and at 3 a.m. vomited 16 ozs. of typical black vomit. Bowels were also moved several times in the next four hours, motions consisting of dark green fluid with chocolate-coloured debris.

9 a.m. Patient very distressed. Subsultus tendinum more pronounced. Headache still present and conjunctivae very injected. Skin has a sallow appearance with petechial eruptions on the arms, thighs, and in the axillae. Temperature 102·6°, pulse rate 69. Patient became quieter towards mid-day, had no more vomiting, and passed an ounce of clear urine, acid reaction and large percentage of albumen present. At 3.30 p.m. bowels were moved again, motions being dark chocolate-coloured fluid ones. Temperature 102·4°, pulse rate 65. Hiccup was troublesome and he vomited one-and-a-half ozs. of black vomit. Towards evening he became quieter and appeared more comfortable, and passed some more urine in small quantities, acid in reaction and with a high percentage of albumen.

At 7 p.m. vomited 10 ozs. of black vomit. Temperature 102·2°, pulse rate 76.

Patient was much quieter during the remainder of the night, and retained all his salines and nourishment.

14*th May*.—1.30 a.m. Passed six drachms of urine, acid reaction and highly albuminous. Bowels moved once, a black, tarry motion.

3 a.m. Patient very restless, complained of nausea and great discomfort in the stomach and vomited 1 oz. of black vomit. Temperature 101·4°, pulse rate 72,

Patient remained quiet until 8 a.m., when he again had an attack of vomiting. and vomited 5½ ozs. of black vomit. No more urine passed since 1.30 a.m.

9.40 a.m. Yellow coloration of skin very pronounced, also of sclerae. Petechial eruption very marked. Temperature 100·8°, pulse 72.

10.30 a.m. Hiccup set in and was troublesome. Vomited half an ounce of black vomit. No urine passed. Bowels moved, motion being black and tarry.

After mid-day, patient became rapidly worse, hiccup was very troublesome and distressing. Black vomit was continuous and the bowels were moved very often, motions being black and tarry. Temperature was raised and pulse rate very low. Patient remained quite conscious throughout until about fifteen minutes before death, when he became comatose, and death took place at 9.35 p.m.

The autopsy was performed next morning, twelve hours after death. Rigor mortis was present. Skin extremely jaundiced. Conjunctivae very yellow. Genital organs cyanosed.

Larynx and trachea.—Mucous membrane very congested.

Pleurae.—Normal, no adhesions. No effusion.

Pericardium.—Normal, contained 2 ozs. of clear fluid.

Lungs.—Normal. No consolidation.

Heart.—Pale and flabby. Valves normal. No haemorrhages.

Peritoneum.—Normal.

Liver.—Weight 48¼ ozs. Pale and friable. Yellow in colour. Greasy on section.

Spleen.—Very congested and friable. Weight 8 ozs.

Stomach.—Very congested. Mucous membrane congested, numerous punctiform haemorrhages, most marked at the cardiac end adjacent to the oesophageal opening.

Duodenum.—Mucous membrane intensely congested, no external appearance of haemorrhages.

Jejunum.—Intensely congested.

Ileum.—Congested at its upper part, congestion gradually lessening towards the caecum. The whole intestine contained a dark, chocolate-coloured fluid. The solitary glands were unusually prominent. No ulceration in any part.

Gall bladder.—Normal.

Kidneys.—Left kidney enlarged. Capsule strips easily. No haemorrhage under capsule. On section somewhat paler than normal. Weight 8¼ ozs. Right kidney similar in appearance to the left. Weight 8¼ ozs.

Pancreas.—Normal.

Bladder.—Normal but contracted, contained about 1 oz. of turbid urine, acid in reaction, and contained a high percentage of albumen.

Brain.—Membranes normal in appearance and not adherent. No congestion or haemorrhages.

Cerebellum.—Normal.

Spinal cord.—Normal.

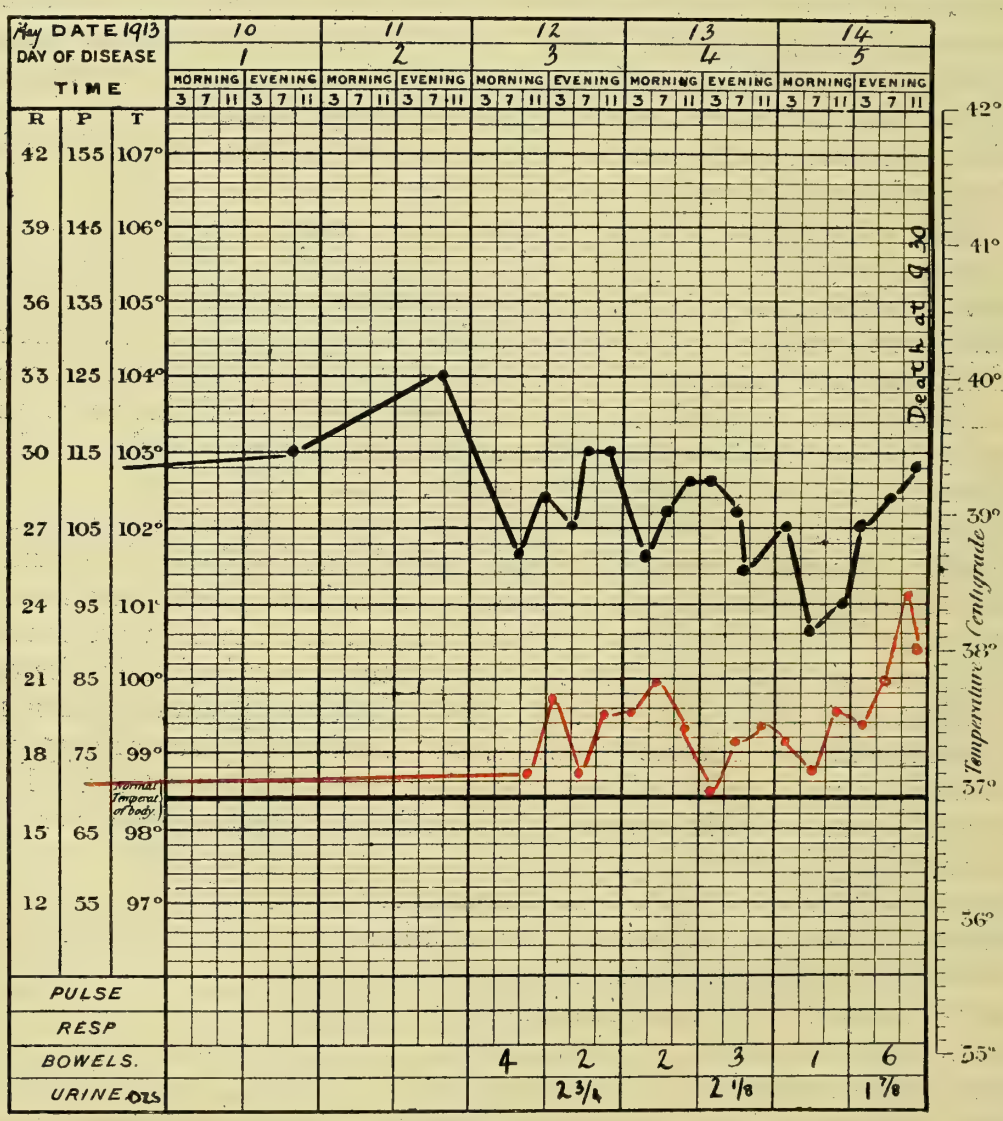


Chart I

Laboratory Report

Liver.—Capsule thickened and contained patches of yellow pigment. Cells were swollen and in a state of fatty degeneration. In some parts profound fatty changes. Some black pigment present.

Kidneys.—Renal epithelium swollen. Lumen of tubules contained granular débris. Glomerular capsules thickened. A few haemorrhages present.

Lungs.—Many alveoli filled with blood. Capillaries in alveolar walls swollen and congested.

Spleen.—Congested. Capsule thickened. Little or no black pigment present.

Report on the Examination of Organs from this Case, by Hubert M. Turnbull, M.D., *Director of the Pathological Institute of the London Hospital, September*, 1913.

Macroscopic Examination

Liver.—A slice from the anterior margin of the liver 1·7 cms. thick and 4 cms. at its broadest. The capsule is smooth and of a purple-red colour, save for a pale area, 0·5 cm. in diameter, near the centre. The cut surface shows a lobular pattern, pale yellowish, small, quadrilateral areas being enclosed by a net of paler lines in which portal vessels can be recognised. A freshly-cut section has a similar appearance.

Kidney.—Half a kidney, 10·5 cms. long and 5·5 cms. broad. The capsule has been partly removed. The exposed surface is of a pinkish-brown colour. On the cut surface the relation of cortex to medulla is as 6 : 10. The demarcation between cortex and medulla is sharp. The cortex is slightly bulged, and is of a pale clay colour. Its pattern is indistinct but straight. The medulla is slightly darker and pinker than the cortex. The arcuate vessels are small.

Spleen.—A triangular slice, 1 cm. thick and with base 2 cms. wide, taken from a rounded edge. The capsule is slightly wrinkled and dark purple in colour. The cut surface is smooth, structureless, and of an even, dirty red colour, except in a zone, 1 mm. wide, beneath the capsule. In this zone white trabeculae are visible in a red ground. As in Case L. 26 (p. 196), the original fixative had evidently failed to permeate the spleen.

Intestine.—A square portion of small intestine, 4 cms. wide. The peritoneum is smooth and flat. The mucosa shows a slightly elevated Peyer's patch and some solitary follicles. The largest of the latter are of the size of a pin's head.

Lung.—A triangular slice of lung, 1·3 cms. thick and having a base 3·5 cms. wide. The capsule is finely nodulated, and of a dark greenish colour. The cut surface is of a very bright red colour and shows a reticular lace-like structure.

Microscopic Examination

The tissue was in spirit on receipt. Microscopic evidence of fixation in formalin is not present in this case.

Portions of the above organs were subjected to the histological methods which have been enumerated in Case L. 26 (p. 197).

Liver.—There is a slight increase in breadth and length of the portal systems, and a thickening of the central veins together with the walls of the capillaries which radiate therefrom. This slight increase of the fibrous stroma of the liver is formed by stout collagen fibres and very few fibroblasts; it is greatest in the tissue close to the capsule.

The other abnormalities in the liver differ only in degree from those described in Case L. 26 (p. 197). Lymphadenoid infiltration of the portal systems is less marked.

The fatty degeneration and necrosis of the hepatic cells is much more extensive and severe. It spares in the same way the narrow zone of cell columns round the portal systems, but affects the whole of the rest of the lobules. Save in the narrow periportal zone the cells are almost without exception necrosed, and the droplets of fat are of the large and medium size. The fat gives the same staining reactions as that in Case L. 26 (p. 198). There is more iron pigment present; numerous granules lie within the cell-columns of the narrow zone round the portal systems, and granules lie also within many of the cells in the necrosed area.

Lining several central veins, and forming masses in some of the adjacent capillaries, numerous bacteria can be recognised even in the haematoxylin and eosin sections. The bacteria are short, very stout, Gram-positive bacilli and more slender Gram-negative bacilli.

Kidney.—There is considerable oedematous swelling of the interstitial tissue. The capillaries are engorged. The red corpuscles are laked, except in a narrow subcapsular zone. The laking is evidently the result of incomplete permeation of the fixative.

The media and intima of the arteries are of normal development. A few droplets of fat are present in the cells of the media of some of the interlobular and afferent arteries.

The glomerular tufts are swollen, their capillaries being engorged. Scattered droplets of fat are present on the surface of the tufts. There is frequently a little granular albuminous material within the capsule. The epithelial cells lining the capsule are flattened.

The cells lining the first convoluted tubules are, as in Case L. 26 (p. 199), swollen, ill-defined, and granular, or finely vacuolated, but there is far less karyolysis and necrosis. The lumina contain a granular débris which resembles the protoplasm of the cells.

There is a little fatty degeneration of the cells of the descending limbs of the loops of Henle, and some of the tubules contain homogeneous albuminous casts.

The degeneration of the epithelium of the ascending limbs of the loops of Henle is severer than that in the first convoluted tubules, and is largely fatty. The epithelium also contains numerous granules of bile pigment.

There is severe fatty degeneration of the second convoluted tubules, so that these tubules are conspicuous when sudan sections are examined under a low power. The majority of these tubules contain aggregations of spherules or homogeneous masses of remarkably eosinophil substance.

The cells lining the collecting and discharging tubules contain a few granules of fat; they are to a large extent desquamated. The lumina of these tubules, particularly the discharging tubules, are distended by casts. The casts consist of homogeneous and finely granular albuminous substance, or deeply eosinophil spherules; many contain desquamated epithelial cells in different stages of degeneration and necrosis. Almost every discharging tubule in the pyramid is distended by these casts.

The casts in the various tubules give Weigert's fibrin reaction with different intensity. The reaction is intense in the deeply eosinophil substance which is found especially in the second convoluted tubules.

In sections stained in Nile-blue-sulphate the fat gives the pink reaction of neutral fat. Iron pigment is not demonstrated by the Turnbull's blue method.

In some of the discharging tubules there are long chains of very large Gram-positive cocci.

There is no evidence of inflammatory reaction on the part of the cells of the blood or the fixed tissues.

The Spleen.—The fixation is imperfect. The red corpuscles are to a large extent laked.

There is no abnormality in the structure of the capsule, trabeculae and vessels.

The Malpighian bodies are small and poorly defined. They have no 'germ centres.' The fibrils of their reticulum are swollen. They contain large numbers of 'free endothelial cells.' Karyokineses are present in some of these cells. A few are multinuclear.

The pulp is greatly engorged. The fibrils of the reticulum of the pulp strands are greatly swollen and ill-defined. There are some 'free endothelial cells' in the pulp, and a very few giant examples with superimposed nuclei. The great majority of the cells in the pulp are swollen, rounded, vacuolated, faintly stained cells in which the nucleus is absent, or shows karyolysis or karyorrhexis, or is relatively small and shrunken in appearance. These vacuolated cells lie for the most part in the pulp strands. Within the protoplasm of a few there are lymphocytes or leucocytes. They frequently contain numerous bodies which are stained by haematoxylin, by methylene blue in Jenner's stain, and by neutral red in Twort's stain, and are decolorised in the Weigert-Gram method. Many of these bodies resemble small, round or oval cocci. They vary, however, very greatly in size and in shape, and transitions can be traced between them and fragmented nuclei. In sections stained by sudan, large granules of fat are present within some of these vacuolated, phagocytic cells. Many contain granules of iron pigment, or give a diffuse iron reaction when stained by the Turnbull's blue method. Transitions can be traced between 'free endothelial cells' and vacuolated phagocytes.

Small Intestine.—*A*. In a section, including the patch of Peyer, the villi are almost without exception necrosed. There is a zone of necrosis on the surface of the Peyer's patch.

The veins and capillaries are engorged, especially in the submucosa and mucosa.

The cells lining the glandular tubules contain a few droplets of mucus. In the stroma of the mucosa there are many neutrophil and eosinophil leucocytes and lymphocytes, and less numerous plasma cells. There are very few free cells in the submucosa.

In the Peyer's patch there are small 'germ centres' which are occupied by large fixed-cells of the reticulum and 'free endothelial cells.' Some of the latter show karyokinesis; a few contain two nuclei. There is a little karyorrhexis in the 'germ centres.' The rest of the lymphadenoid tissue contains a considerable number of eosinophil leucocytes and a few 'free endothelial cells.'

There are a few small granules of fat in some of the muscular fibres of the media of the large arteries of the submucosa. The granules are stained pink in Nile-blue.

On the surface of the mucosa, and within the necroses thereof, there are large numbers of Gram-positive bacteria. The great majority of these are large, stout bacilli. A few cocci and diplococci are also present.

B. In a section, including a large and small solitary follicle, there is much less necrosis. The epithelium of the villi is desquamated and necrosed, but only a few entire villi are necrosed. There is a broad zone of necrosis upon the surface of the large solitary follicle. There are small valvulae conniventes. In the smaller solitary follicle a 'germ centre' is indicated by a central area containing many 'free endothelial cells.' There is no 'germ centre' in the larger follicle. In other respects the section is similar to that of *A*.

In the necrosed desquamated epithelium and on the surface of the necrosed tissue there are numerous Gram-positive bacilli similar to those in section *A*.

Lung.—The pleura is thin. In places its lymphatics contain a considerable quantity of coal pigment. On the surface there is a deposit of granular substance which does not give the reaction for fibrin; it appears to be derived from broken down red corpuscles.

The bronchioles have no epithelial lining; they contain red corpuscles or a granular débris in which red corpuscles can be recognised.

The pulmonary arteries contain a finely granular eosinophil substance, amongst which there are sometimes red corpuscles.

Many of the infundibula are distended by air. A large number of infundibula and alveoli contain either discrete, swollen red corpuscles, or a homogeneous mass of faintly-stained red corpuscles, or a homogeneous or granular mass in which red corpuscles are no longer recognisable.

There is no evidence of inflammatory infiltration in the lung; only a very few leucocytes are present in the blood within the air passages.

The nuclei throughout are pyknotic. The elastic fibres cannot be stained. The tissues and blood have the brown coloration and the eosinophilia which are associated with acid digestion.

There are numerous masses of bacteria on, and in, the pleura and in the haemorrhagic air passages, these include Gram-positive cocci which are arranged in bunches or chains. There are also groups of stout, Gram-positive bacilli and short oval vacuolated bacilli or diplococci. Bacteria of various kinds, especially bacilli, are also scattered through the tissues.

For further remarks on this case by Dr. Turnbull, see p. 201.

Case No. 2. L. 23

Sex: Male.
Age: 25 years.
Nationality: Negro, Yoruba tribe.
Occupation: Tailor.
Date of admission: 14th May, 1913.
Date of discharge: 31st May, 1913.
Diagnosis: Mild yellow fever.

History.—Patient states that his illness began on the 7th May, with a severe headache, rigors, and constipation. He felt very ill and had to go to bed. Had a restless night and no sleep. Next day, he was much the same, headache severe and aches and pains all over the body. He took quinine and also an aperient and his bowels were opened. On the 10th, he was in much the same condition; severe frontal headache, pyrexia and nausea, no vomiting. He was confined to bed and felt very ill. On the 14th he felt very much worse and decided to come to the hospital for treatment.

On admission.—Patient was greatly distressed, sweating profusely. Lips dry. Conjunctivae injected and red. Temperature 102·6°.

Alimentary system.—Tongue was dry and red. Liver normal, no tenderness. Spleen shows slight enlargement, no tenderness or pain. Epigastrium tender on pressure. Nausea present. Bowels had been opened.

Respiratory system.—Lungs normal. Respirations hurried, 24 per minute.

Circulatory system.—Heart sounds were normal, pulse 98.

Urinary system.—Four ozs. of urine passed at 5 p.m. Examination: Dark red in colour. Acid reaction. Sp. gr. 1030. Albumen present.

Blood examination.—No malaria parasites present. Leucopenia present.

Differential count: Polymorphonuclear, 80 per cent.; mononuclear, 10 per cent.; lymphocytes, 10 per cent.

Temperature rose in the afternoon at 4 p.m. to 104·8°, pulse rate 98. Bowels were opened after calomel. Epigastrium tender on pressure. No vomiting.

15*th May*.—Patient had a restless night, did not sleep. Passed urine several times. Urine was still high-coloured, acid in reaction, and contained albumen. Temperature at 8 a.m. was 102·4°, pulse rate 92, and at 8 p.m. 101·6°, with pulse rate 88.

16*th May*.—Patient passed a fair night and slept better. Headache not so severe. Conjunctivae still injected. Tongue coated, tip and edges red. Patient is passing a larger amount of urine, lighter in colour, acid reaction and albumen still present. Temperature at 8 a.m. was 101°, pulse rate 88, rose towards afternoon, and at 8 p.m. was 101·6°, pulse 88.

17*th May*.—Patient had a better night, slept better and feels much improved. Jaundice appeared yesterday in the sclerae and is more marked to-day. Urine increased in amount and the albumen is lessened. Temperature is still above the normal.

18*th May*.—Patient had a good night, is feeling much better. Headache is

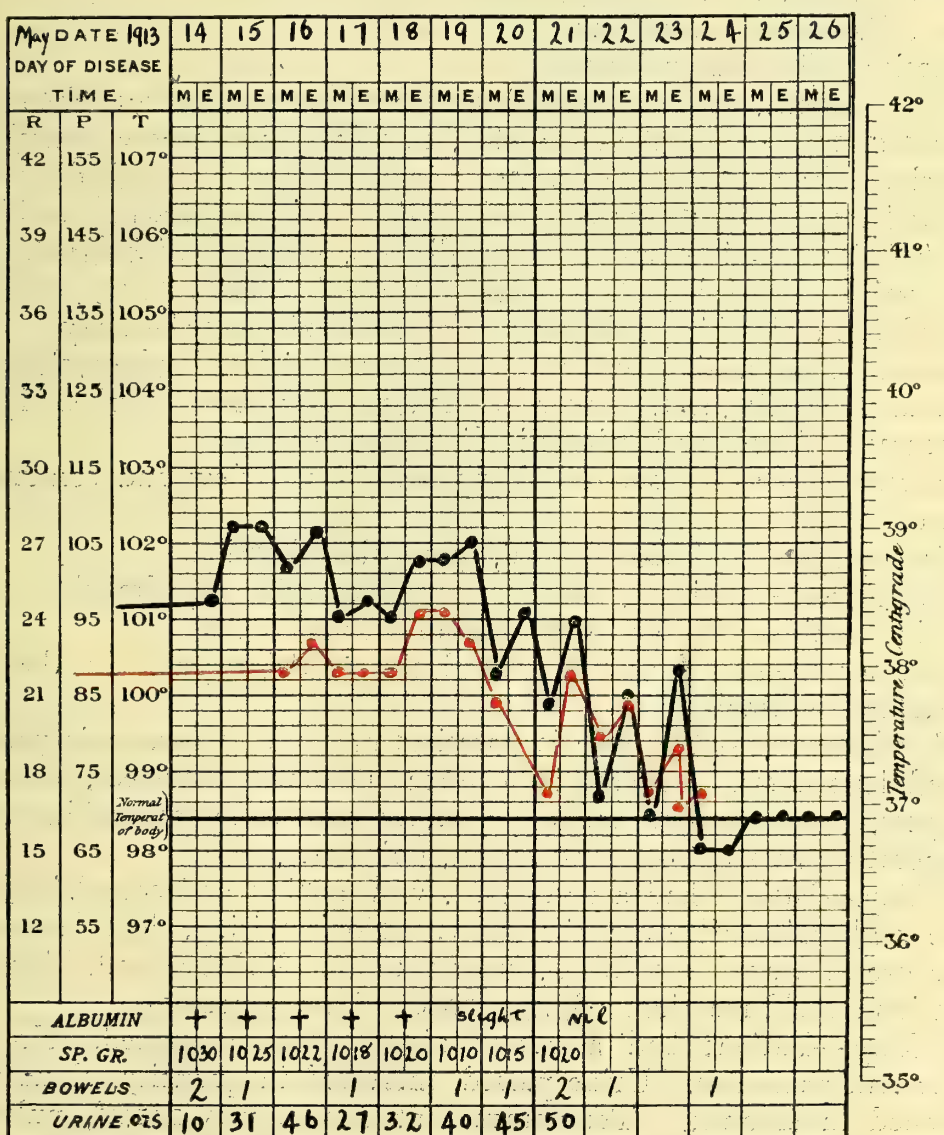


Chart 2

much less and the conjunctival injection disappearing, while the jaundice is more marked. Urine is increased in quantity and on examination is acid in reaction, sp. gr. 1020, albumen still present but lessened. Temperature is still raised.

19*th May*.—Patient is much improved, had a very good night. Appetite returning, epigastralgia and nausea have disappeared. Bowels regular. Urine is returning to the normal. Examination shows the presence of albumen but lessened in amount.

Patient continued to improve steadily, appetite increased. Bowels regular. Headache and conjunctival injection passed off while jaundice became more marked. Albumen disappeared from the urine on the 22nd May and bile made its appearance. Dietary was increased and the patient made an uneventful recovery and was discharged from the hospital on the 30th May.

Case No. 3 L. 25

Sex: Male.
Age: 29 years.
Nationality: Negro, Effik tribe.
Occupation: Labourer.
Date of admission: 15th May, 1913.
Date of discharge: 30th May.
Diagnosis: Mild yellow fever.

History.—Patient, a labourer working at the Customs, came to the out-patient department at 12 noon on the 15th May, complaining of severe frontal headache and pyrexia. His temperature was 102° and he seemed greatly distressed. He stated that he had been ill for the past six days and unable to go to his work.

On admission.—Patient was in great distress, respirations hurried. Sweating freely. Conjunctivae injected. Temperature 102°, pulse rate 98. Complains of severe headache and aching pains in the loins and all over the body.

Alimentary system.—Tongue dry and coated, tip and edges clean. Bowels constipated. Appetite lost. Liver normal, no tenderness. Spleen is enlarged, no tenderness. Nausea and epigastric discomfort present.

Circulatory system.—Heart sounds normal. Pulse slow and compressible, 98 per minute.

Respiratory system.—Lungs normal, respirations hurried.

Urinary system.—Patient passed six ounces of urine on admission. Examination: Acid reaction. Sp. gr. 1025. Albumen present.

Nervous system.—Severe frontal headache. Aching pains in the loins and body. Reflexes normal.

Blood examination.—No malaria parasites present. Leucopenia present. No pigmented leucocytes. Differential count: Polymorphonuclear, 76 per cent.; lymphocytes, 15·2 per cent.; mononuclear, 4·6 per cent.; eosinophil, 4·2 per cent.

Temperature rose to 103·2° at 8 p.m., pulse rate, 96.

16*th May*.—Patient had a bad night, very restless and complained of severe headache and pains all over the body. No vomiting, but nausea present. Temperature at 8 a.m. was 102·4°, pulse rate 88. Urine passed, high in colour. Examination: Acid reaction. Sp. gr. 1020, albumen present.

17*th May*.—Patient had a better night. Bowels opened. No vomiting. Headache and pains less. Urine passed, increased in quantity, albumen present but lessened in amount. Temperature at 8 a.m. was 101·4°, pulse rate 78. Temperature rose towards evening and was 103·4° at 8 p.m. with a pulse rate of 84.

18*th May*.—Patient had a quiet night, slept better. Headache and pains have gone. Bowels were opened freely. Urine passed in large quantity. Albumen still present but lessened in amount. Conjunctivae are now yellow. Appetite returning. Temperature still raised.

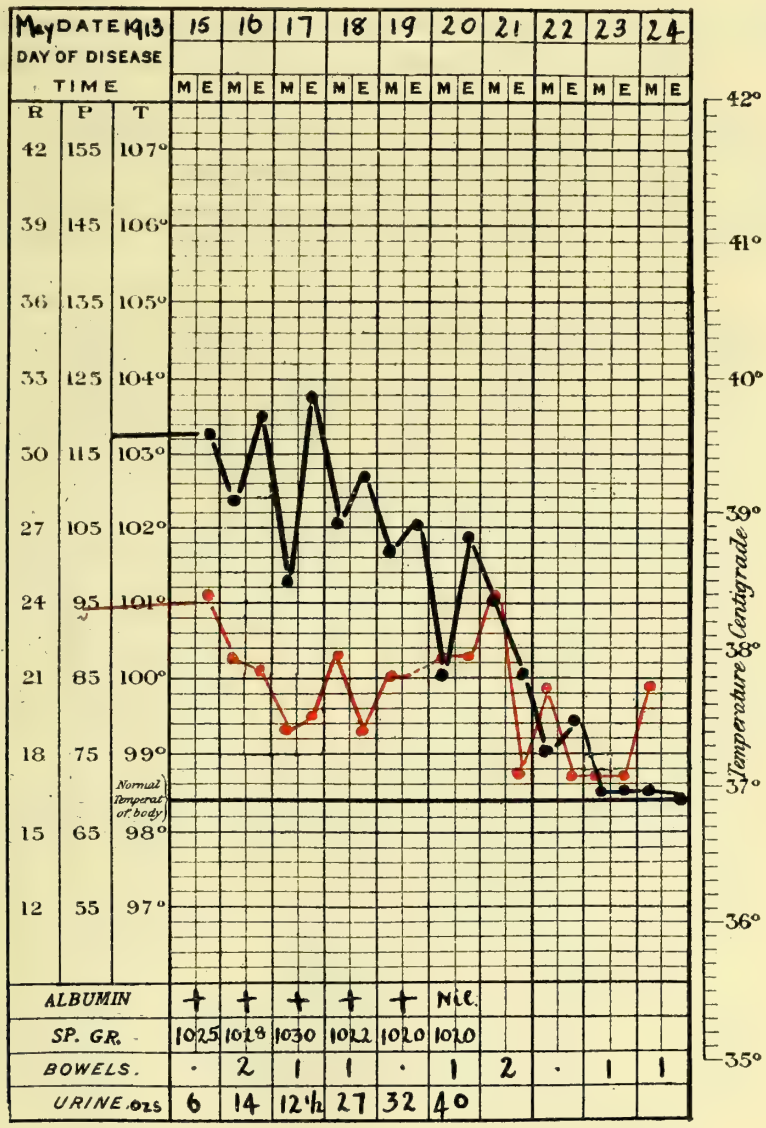


Chart 3

Patient continued to improve daily, jaundice deepened. Bowels became regular. Appetite increased. Urine increased in quantity and on the 20th May albumen disappeared from the urine and bile appeared.

Patient made an uneventful recovery and was discharged cured on the 30th May.

Case No. 4. L. 24

Sex: Male.
Age: 22 years.
Nationality: Negro, Yoruba tribe.
Occupation: Sanitary inspector.
Date of admission: 16th May, 1913.
Date of discharge: 30th May, 1913.
Diagnosis: Mild yellow fever.

History.—Patient states that he began to feel ill about six days ago, the illness beginning with headache, rigors, and aching pains all over the body. He also had pyrexia. He continued at his work but got worse and reported sick and was sent to hospital.

On admission.—Patient was admitted into hospital at 3.45 p.m. on the 16th May, complaining of fever, severe frontal headache and general aching pains. Bowels were also confined. He seemed very distressed. Conjunctivae injected and red.

Alimentary system.—Appetite lost. Bowels constipated. No vomiting. Nausea present. Tongue coated, with tip and edges clean. Liver normal. Spleen normal, no tenderness. No epigastralgia present, but this was present two days ago.

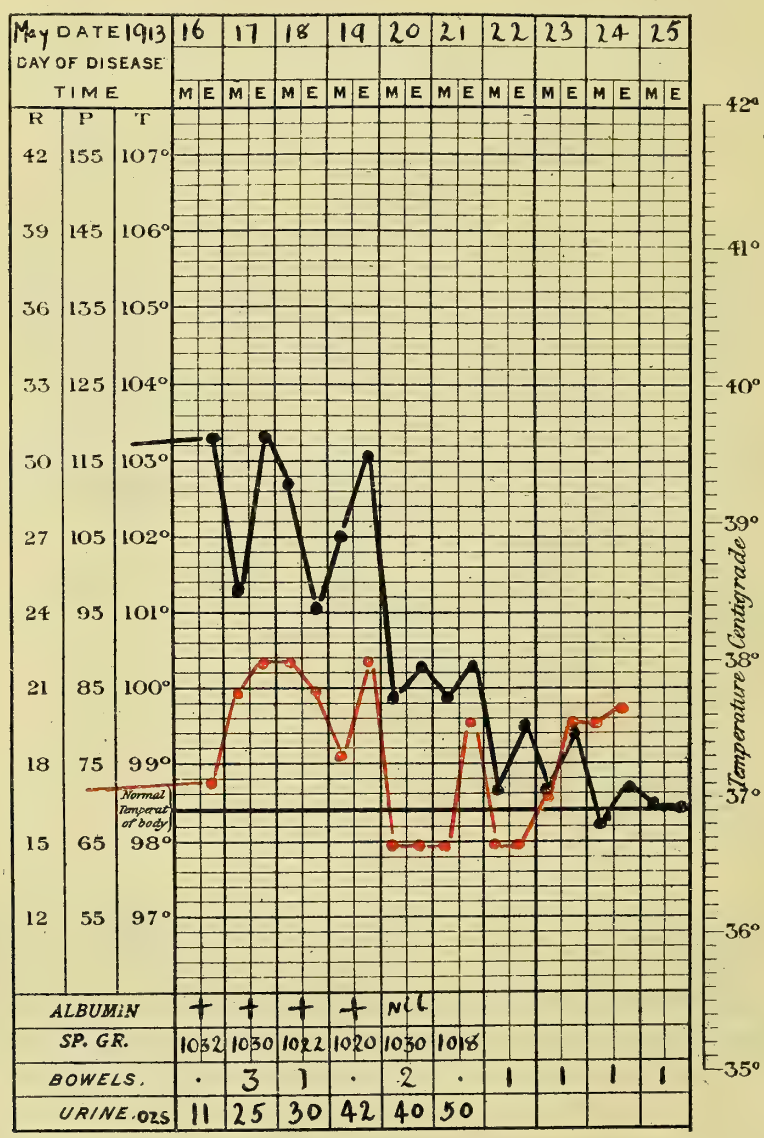


Chart 4

Circulatory system.—Heart sounds normal. Pulse: low tension, 82 per minute.

Respiratory system.—Lungs normal, respirations hurried.

Nervous system.—Frontal headache and aching pains in the loins and extremities. Reflexes normal.

Urinary system.—Patient had passed no urine since early morning and passed

none after admission until 6 a.m. next day, the 17th. Examination: Reaction acid. Sp. gr. 1032. Albumen present.

Blood examination.—No malaria parasites present. Leucopenia present. Differential count: Polymorphonuclear, 80 per cent.; mononuclear, 10 per cent.; lymphocytes, 10 per cent.

Temperature on admission was 103·2°, pulse rate 82.

17th May.—Patient had a very restless night, did not sleep. Temperature was raised, being 104° at 8 p.m. with a pulse of 82. Passed no urine during the night. Headache and pains were very severe. At 6 a.m. passed six ounces of very highly coloured urine which contained albumen. Temperature at 8 a.m. was 101·4°, pulse 84. Had an attack of vomiting, dark green fluid with brown debris. Temperature rose in the evening and at 8 p.m. was 103·4° with a pulse of 88. Bowels were opened twice.

18th May.—Patient had a better night, is more comfortable and the headache and pains are lessened. Passed urine but still diminished in quantity, high coloured and containing albumen. Temperature at 8 a.m. was 102·6°, pulse rate 88; at 8 p.m. it was 101, pulse 84. Sclerae are now tinged with yellow.

19th May.—Patient much better, had a better night. Bowels opened. No further vomiting. Urine increased in amount. Still contains albumen but the percentage is lessened. Temperature at 8 a.m. was 102°, pulse rate 75. Temperature rose towards evening and at 8 p.m. was 103·2°, pulse 88. Conjunctivae are not so injected, sclerae are yellow.

20th May.—Patient is very much better. Headache has quite gone. Bowels regular. Temperature falling. Urine has increased in amount and on examination is acid, sp. gr. 1020, no albumen present. Sclerae are very yellow. Appetite has improved.

Patient continued to do well and slowly improved. Jaundice disappeared on the 26th May and he was discharged from the hospital on the 30th May.

Case No. 5. L. 35

Sex: Male.
Age: 26 years.
Nationality: Negro, Krooboy.
Occupation: Motor mechanic.
Date of admission: 26th May, 1913.
Date of discharge: 12th June, 1913.
Diagnosis: Mild yellow fever.

History.—Patient is employed at the Woermann Linie at their works at Apapa. Last Thursday, the 22nd, he began to feel ill with severe frontal headache, pains and aches all over the body, especially marked in the loins, and fever. Bowels were constipated and he had nausea. He tried to do his work but got worse and was sent to the hospital this morning. He noticed that his urine was very scanty.

On admission.—Patient was sweating freely and appeared greatly distressed. Complains of severe frontal headache with orbital pains, and aching pains in the loins. No vomiting, but he has nausea with pain and discomfort in the epigastrium

Alimentary system.—Tongue is coated, with tip and edges clean. Appetite lost. Bowels constipated. Liver is normal. Spleen is normal but tender on pressure. Epigastrium distinctly tender, and pressure causes pain.

Circulatory system.—Heart sounds are normal. Pulse 88, low tension and compressible.

Respiratory system.—Lungs normal, respirations hurried.

Nervous system.—Severe frontal headache. Aching pains in the loins and extremities.

Urinary system.—Patient states that his urine has been scanty. Examination: high coloured. Sp. gr. 1025. Albumen present.

Blood examination.—No malaria parasites present. Pigmented leucocytes present. Leucopenia present. Differential count: Polymorphonuclear, 71 per cent.; lymphocytes, 20 per cent.; mononuclear, 4 per cent.; eosinophil, 5 per cent.

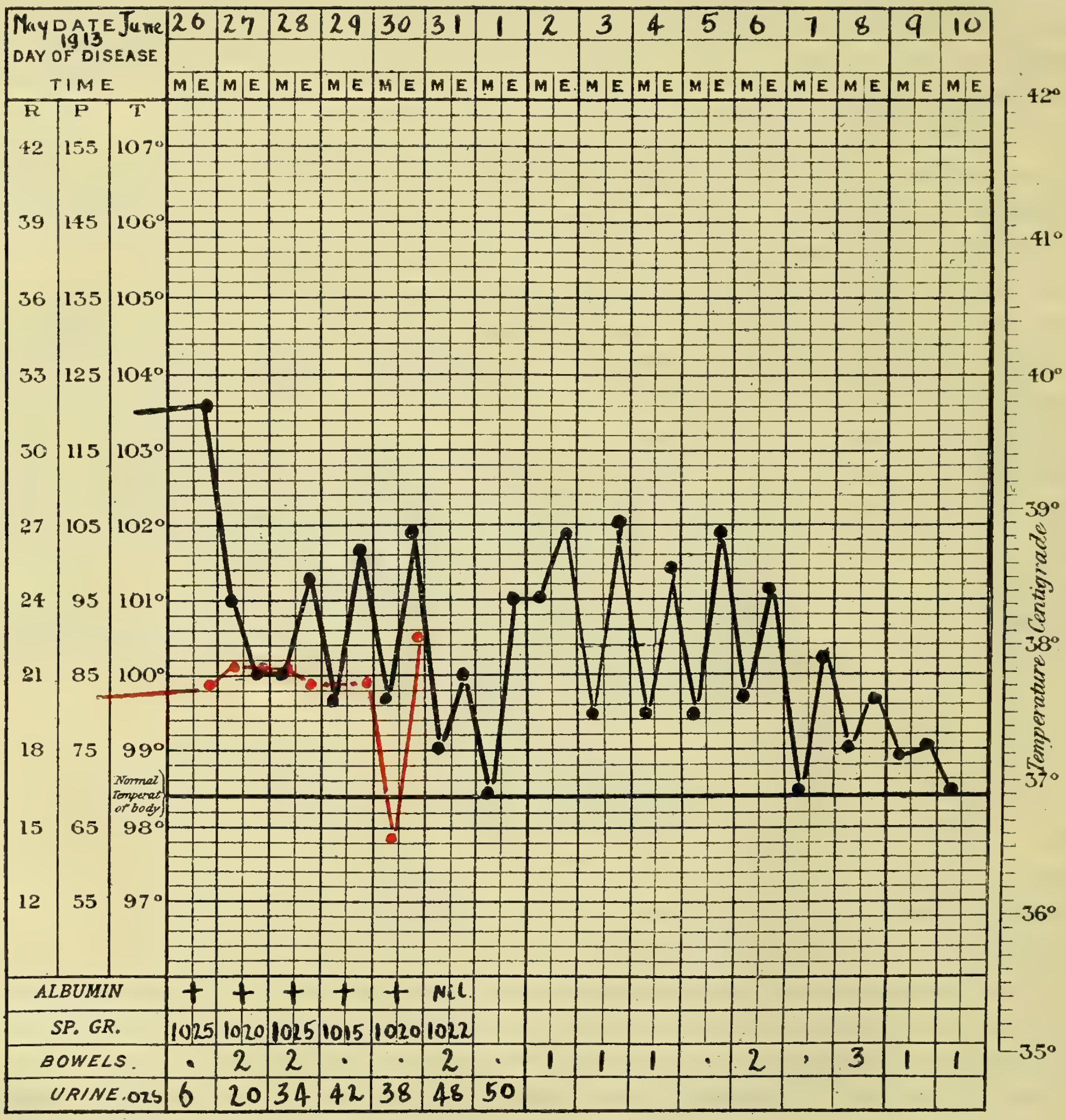


Chart 5

Temperature on admission was 101·2°. Pulse rate, 80.

27th May.—Patient had a fair night. Headache still present. Bowels freely opened after the calomel. Urine passed freely and, on examination, contains albumen. No vomiting, epigastralgia and nausea still present. Temperature at 8 a.m. 101, pulse rate 86. During the night the temperature was 103°, with a pulse rate of 84.

28th May.—Patient much better and had a good night. No vomiting, nausea is passing off. Headache still present, but slight. Sclerae are yellow. Urine increased in quantity, but still contains albumen. Temperature at 8 a.m. was 100°, pulse 86, and during the afternoon it rose to 102·6°, with a pulse rate of 80.

Patient continued to do well, appetite improved, bowels were regular. Urine increased in quantity, and albumen disappeared on the 30th, bile making its appearance. Sclerae remained jaundiced until the 8th June and then cleared up. Patient made an uneventful recovery and was discharged on the 12th June.

Case No. 6. L. 36

Name: Mr. F.
Sex: Male.
Age: 21.
Nationality: European, German.
Occupation: Marine engineer.
Date of admission: 28th May, 1913.
Date of discharge: 24th June, 1913.
Diagnosis: Malarial fever complicated with yellow fever.

History.—Patient, a marine engineer of the s.s. 'Epe,' of the Woermann Linie, sailing between Lagos and Porto Novo, was admitted into hospital on the 28th May, suffering from pyrexia. Temperature on admission was 103·4°, pulse rate 92. Present illness began on the 24th with general malaise and frontal headache. Bowels were constipated. No vomiting, but nausea was present. He was much the same for the next three days, and vomiting set in, and he could not keep down any food. He was seen on the morning of the 28th, and as his temperature was 104° he was sent to the hospital. Patient is a new arrival and has only been out on the Coast for three months.

On admission.—Patient looks very ill and distressed. Complains of severe frontal headache and pains in the eyes. Conjunctivae are injected. Soon after admission temperature rose to 105°, pulse rate 92.

Alimentary system.—Tongue is coated, tip and edges clean and red. Bowels constipated. Pharynx shows chronic pharyngitis. Liver is normal. Spleen is also normal, no tenderness. Nausea present. Vomiting has stopped.

Respiratory system.—Lungs normal. Respirations hurried.

Circulatory system.—Heart sounds are normal. Pulse slow, low tension.

Nervous system.—Severe frontal headache and orbital pains. Aching pains in the loins and limbs. Reflexes normal.

Urinary system.—Patient states that his urine has been scanty. On examination: Acid reaction. Sp. gr. 1020. Albumen present.

Blood examination.—Young ring forms of malaria parasites present. No pigmented leucocytes. Differential count: Polymorphonuclear, 71·5 per cent.; lymphocytes, 23 per cent.; mononuclear, 2 per cent.; eosinophil, 5 per cent.; transitionals, 3 per cent.

Face is flushed, conjunctivae injected and red.

Temperature remained high all the afternoon, and at 6 p.m. it was 104·6°, with a pulse rate of 92. No urine passed, except a small quantity, one ounce, on admission. Nausea very troublesome, no vomiting, bowels confined. Temperature at 8 p.m. was 103·6°, pulse rate 98.

29th May.—Patient had a quiet night, temperature fell. Patient retained his nourishment. Urine passed, 15 ounces, after fomentations and salines. Epigastrium very tender, with great discomfort in the stomach. Conjunctivae very injected. Urine is acid in reaction, sp. gr. 1025, albumen present. Headache still present and severe.

30th May.—Patient had a fair night, slept on and off. Vomiting present in

the early hours of the morning, which relieved the epigastric discomfort. Urine passed in increased quantity, and still contains a large percentage of albumen. Temperature at 8 a.m. was 100·2°, pulse rate 90. Temperature rose again in the afternoon and the patient had several attacks of vomiting. Temperature at 8 p.m. was 102·4°, pulse 90.

31*st May*.—Patient had a bad night, very restless and no sleep. No further vomiting. Bowels were opened. Urine passed, but diminished in amount, albumen still present. Temperature at 8 a.m. 100·6°, pulse rate 84, and at 8 p.m. temperature 100·8°, pulse rate 74. Headache still present.

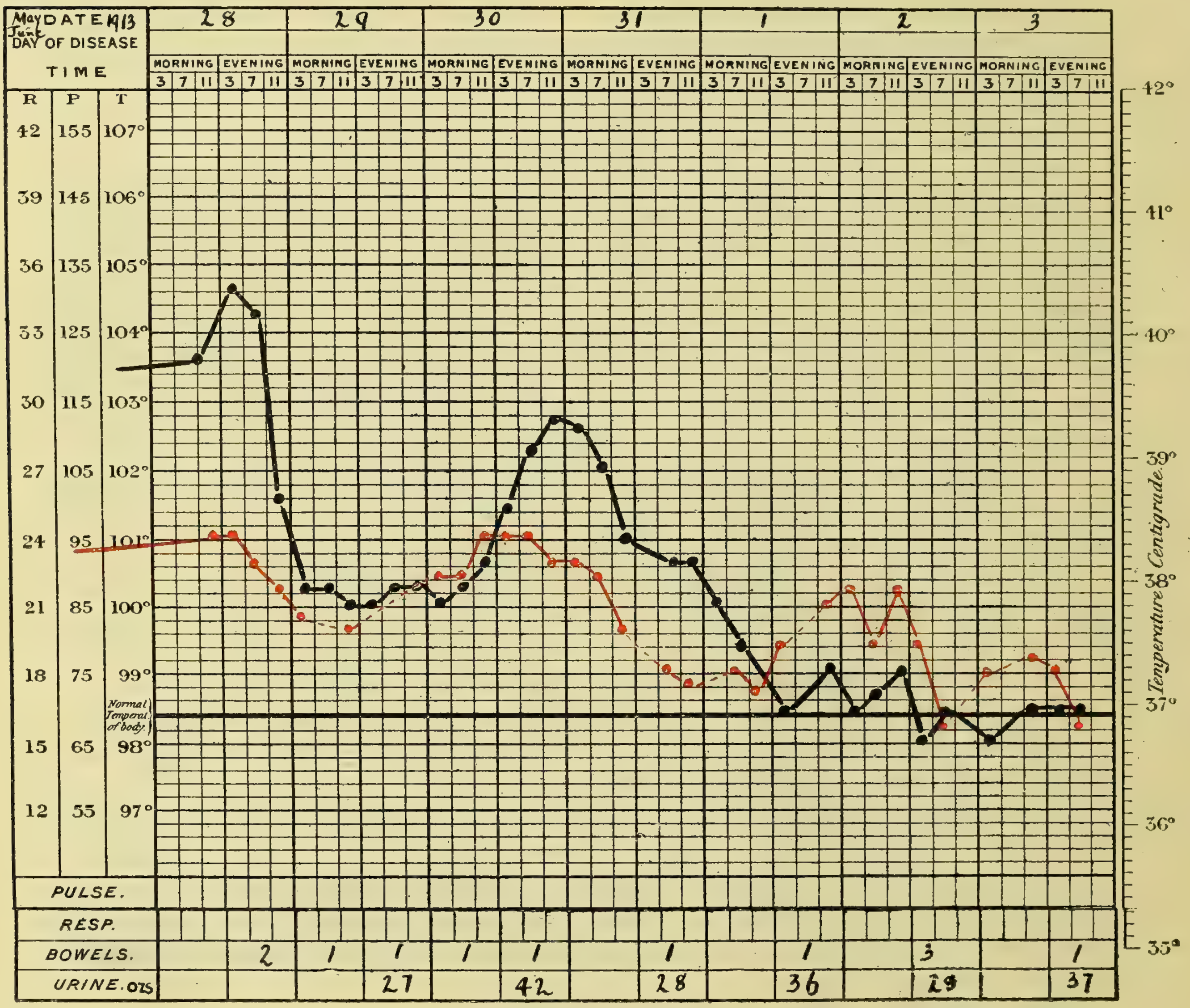


Chart 6

1*st June*.—Patient had a better night, and slept fairly well. Bowels had been confined but were opened by enema. Urine still showed the presence of albumen, but the quantity passed had increased. At 11 a.m. the patient said he felt very ill, pulse rate was 73. Bowels were moved and the motion contained melaena. At 12 he had an attack of vomiting, and the vomited matter was a dark brown fluid with dark débris. Patient looked very ill and distressed. Pulse was irregular, 73 per minute. Towards evening his condition improved, and there was no more vomiting.

2nd June.—Patient had a better night and his condition is greatly improved. No more vomiting, but nausea is present, with epigastric discomfort. Urine passed in increased amount but still contains albumen. Temperature has fallen, pulse is slow and of low tension.

3rd June.—Patient very much better, had a good night and feels better. Appetite is returning. Nausea and epigastric discomfort have gone. Patient retains all his nourishment. Bowels have been opened. Temperature has fallen, but pulse is still low and irregular.

Skin is very sallow and the sclerae are tinged with yellow. Urine examination: Acid reaction, sp. gr. 1020, no albumen present.

4th June.—Patient doing well, appetite returning. Bowels regular and urine normal in quantity, albumen has disappeared. Skin sallow and sclerae yellow.

Patient continued to progress favourably, the jaundice disappeared on the 8th June and the patient was discharged from the hospital on the 24th June.

Case No. 7. L. 37

Sex: Male.
Age: 34.
Nationality: European, British.
Occupation: Bank accountant.
Date of admission: 17th July, 1913.
Date of death: 20th July, 1913.
Diagnosis: Yellow fever.

History.—Patient states that on the 16th he began to feel ill about mid-day with chilly sensations, followed by frontal headache. He finished his work and in the evening had to go to bed as he was feeling worse. The headache had increased in severity and he had racking pains in the loins and limbs. He was seen by a doctor that night, and also next morning, and as his condition seemed serious he was sent into hospital.

Patient has had several attacks of malarial fever. Present tour in Lagos $7\frac{1}{2}$ months' duration. Has kept good health up to the present.

On admission.—Patient complains of great and severe frontal and ocular headache with racking pains in the loins and extremities. Face is flushed, conjunctivae injected and the eyes shining and watery. Bowels have been confined, nausea is present, and he has pain and discomfort in the epigastrium, increasing on pressure.

Alimentary system.—Bowels are constipated, appetite lost. Tongue is pointed, with red tip and edges and furred dorsum. Liver is normal, no tenderness. Spleen is also normal. Epigastrium is tender and painful on pressure.

Circulatory system.—Heart sounds are normal. Pulse is slow, low tension, 96 per minute.

Respiratory system.—Lungs normal. Respirations hurried.

Nervous system.—Severe frontal headache and pains in the eyes. Racking pains in the loins and extremities. Reflexes normal.

Urinary system.—Urine is very cloudy and diminished. Examination: Acid. Sp. gr. 1022. Albumen present.

Blood examination.—No malaria parasites present. Pigmented leucocytes present. *Paraplasma flavigenum* present. Differential count: Polymorphonuclear, 78 per cent.; mononuclear, 7 per cent.; lymphocytes, 13 per cent.; eosinophil, 2 per cent. Leucopenia present.

Temperature on admission at 10 p.m. was 103·8°, pulse rate 96.

18*th July*.—Patient had a quiet night, headache not so severe this morning. Eyes injected and shining. At 8 a.m. temperature was 104°, with a pulse rate of 80. About 10 a.m. patient felt uncomfortable in the stomach and caused himself to vomit. Vomited matter consisted of a dark brown fluid with chocolate-coloured débris. Bowels moved at 10.30 a.m., motion being a greenish fluid with chocolate-coloured débris. Vomiting stopped after the application of a sinapism, but nausea and gastric discomfort were present. Temperature at 104° all the evening and at 8 p.m. was 104·4°, pulse rate 70. Bowels were again moved at 8 p.m. and the motions contained dark chocolate-coloured débris. Passed eight ounces of very muddy urine, which contained a large amount of albumen.

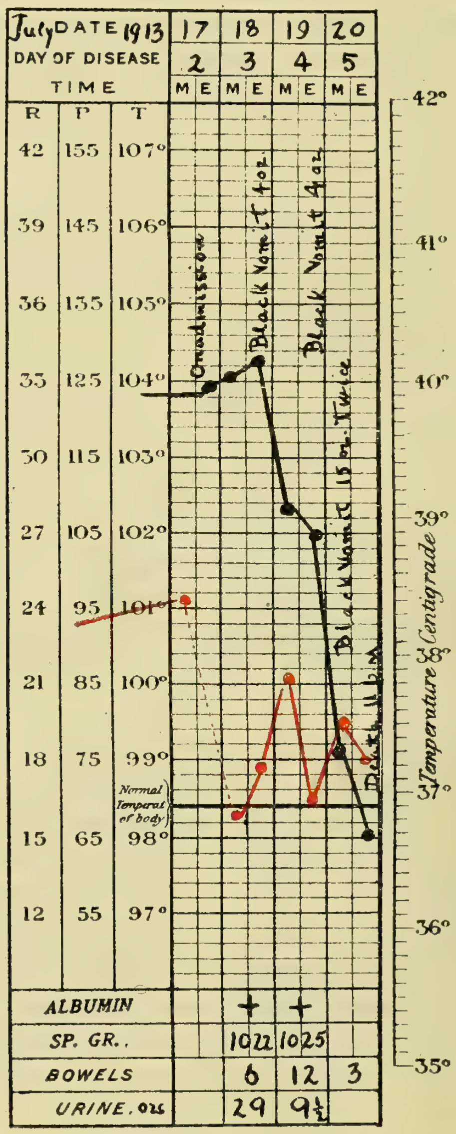


Chart 7

19*th July*.—Patient had a restless night and did not get much sleep. During the early hours of the morning, patient had several motions and the stools were dark and chocolate-coloured. Eyes were still injected. Epigastric pain and discomfort with nausea present. An erythematous rash appeared on the skin of neck and chest. Urine was diminished and contained a large percentage of albumen. Temperature at 8 a.m. was 102·4°, pulse rate 64. In the afternoon at 5.20 p.m., patient had an attack of vomiting, four ounces of black vomit. Bowels moved again and the stools were black and tarry. No urine passed except the one ounce

at 1 p.m. Black vomit again occurred at 7.15 p.m. and petechial haemorrhages appeared in the skin of neck, chest and back. The temperature at 8 p.m. was 101·8°, pulse rate 68. Only 1½ ounces of urine passed in the twelve hours.

20th July.—Patient had a fair night and was quieter. Bowels moved several times towards morning; the stools were black and tarry. No more vomiting during the night, but at 8.40 a.m. he had a severe attack and vomited 12 ounces of black vomit. No urine was passed through the night. Skin was jaundiced. Temperature 101·4°, pulse rate 68. Conjunctivae showed small haemorrhages and the sclerae were deeply jaundiced. Patient became much worse towards the evening. Very restless, with subsultus tendinum very marked. Ecchymoses of the genital organs very pronounced. Urine suppressed. Delirium present. Vomiting became almost continuous, typical black vomit. Patient's condition became very serious, skin deeply jaundiced, petechial haemorrhages more pronounced. Very restless and delirious. At 10 p.m. convulsions set in and lasted for about an hour, and death occurred at 11 p.m.

Post-Mortem Notes

Autopsy was performed nine hours after death.

Rigor mortis present. Skin deeply jaundiced. Post-mortem staining of dependent parts. Genital organs cyanosed. Palms of hands and soles of feet stained a deep yellow. Petechial haemorrhages in skin of neck, back, and chest. Subconjunctival haemorrhages in both eyes.

Brain.—Normal. No congestion.

Spinal cord.—Normal.

Membranes.—Normal.

Heart.—Pale and flabby. Valves normal. No haemorrhages. Weight, 8½ ounces.

Large vessels.—Normal.

Lung, right.—Bronchi deeply congested. Base of lung congested and areas of haemorrhage present.

Lung, left.—Same appearance as right.

Pleurae.—No adhesions present. Each cavity contained four ounces of yellow fluid. No haemorrhages.

Larynx and trachea.—Deeply congested.

Peritoneum.—Normal.

Oesophagus.—Intensely congested.

Stomach.—Contained ten ounces of black fluid. Mucous membrane congested. Rugae swollen and thrown into corrugations. Patches of haemorrhage in mucous membrane, most marked at the cardiac end and along the lesser curvature. Large haemorrhage in posterior wall.

Small intestine.—Duodenum intensely congested. Submucous haemorrhages along its entire length. Jejunum also congested and haemorrhages present. Ileum congested for about half its length. The intestinal canal contained a dark, tarry fluid.

Large intestine.—Mucous membrane congested and gelatinous in appearance near the ileo-caecal valve. Empty.

Helminths.—None present.

Liver.—Pale, boxwood colour. No haemorrhages in capsule. On section, greasy. Very friable. Weight 58½ ounces.

Gall bladder.—Empty. Mucous membrane congested.

Pancreas.—Normal. Weight 5 ounces.

Spleen.—Slightly enlarged and congested. Weight 7½ ounces.

Kidney, right.—Enlarged. Capsule strips easily. Dilated stellate veins under capsule. Weight 8½ ounces.

Kidney, left.—Enlarged. Capsule strips easily. Weight 8 ounces.

Suprarenal capsules.—Normal.

Lymphatic system.—Normal.

Bladder.—Contracted and contained half-ounce of very dark brown urine. Highly albuminous on examination. Mucous membrane normal.

Laboratory Report

Microscopic examination :

Blood smears showed the presence of *Paraplasma flavigenum.* No malaria parasites.

Histological examination :

Liver.—Advanced fatty degeneration. Cells vacuolated and protoplasm granular. Distorted arrangement of lobules.

Kidney.—Cells swollen and granular. Tubules denuded of epithelium in places and filled with granular and hyaline débris. Droplets of fat in cells of convoluted tubules. Several small haemorrhages.

Stomach.—Mucous membrane swollen and vessels congested. Punctiform haemorrhages present.

Spleen.—Congested. Capsule thickened.

Case No. 8. L. 38

Sex : Male.
Age : 40 years.
Nationality : Syrian.
Occupation : Clerk.
Date of admission : 19th July, 1913.
Date of death : 22nd July, 1913.
Diagnosis : Yellow fever.

History.—Patient states that his illness began yesterday, the 18th, with a sense of chilliness, followed by frontal headache, aching pains in the loins and limbs. Temperature rose and he had to go to bed. He had no vomiting, but nausea, with discomfort in the epigastrium, was present. The headache and loin pains increased at night, he had a very restless night. Bowels were constipated and urine was high coloured. On the morning of the 19th, he felt very much worse and was seen by a doctor, who advised his removal to hospital.

On admission.—Patient was admitted into hospital at 2.55 p.m. on the 19th. The temperature was 101°. He was very distressed, respirations hurried, conjunctivae injected and red, eyes watery. Face was flushed, skin dry and hot.

Alimentary system.—Tongue clean, tip and edges red. Bowels constipated. No vomiting. Nausea present. Epigastric pain and discomfort present. Liver normal. Spleen normal, slight tenderness present.

Circulatory system.—Heart sounds were normal. Pulse 94, low tension, compressible.

Respiratory system.—Lungs normal. Respirations were hurried.

Nervous system.—Severe frontal headache. Severe aching pains in the loins and extremities. Reflexes normal.

Urinary system.—Passed urine on admission. Examination : Acid reaction. Sp. gr. 1015. No albumen.

Blood examination.—No malaria parasites present. *Paraplasma flavigenum* present. Pigmented leucocytes present. Differential count: Polymorphonuclear, 78·7 per cent.; lymphocytes, 12 per cent.; mononuclear, 8·3 per cent.; eosinophil, 1 per cent.

20*th July.*—Patient had a very restless night. Vomited twice. Bowels were opened freely after calomel. Temperature at 8 a.m. was 102°. Pulse rate 80. Passed urine during the night. Examination showed urine to be acid, and highly albuminous. Sp. gr. 1020. Patient was very distressed, headache severe, conjunctivae injected and eyes shining. Temperature rose during the evening, at 4 p.m. being 103·4°, pulse 82, and at 8 p.m. it was 103·4°, pulse 84. Urine diminished and only 2½ ounces passed since noon until 8 p.m., urine being high coloured and highly albuminous.

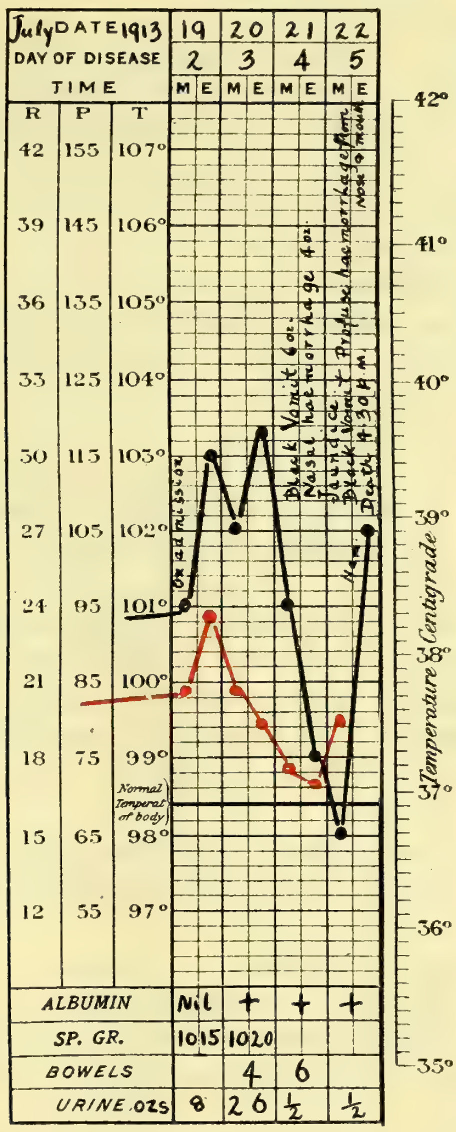


Chart 8

21*st July.*—Patient passed a quiet night, but did not sleep much. Passed no urine since 8 p.m. the night before. Temperature at 8 a.m. was 101°, pulse rate 72. Vomiting set in about 11 a.m., the vomit consisting of a colourless fluid with chocolate-coloured débris. Towards the afternoon patient was very distressed, headache severe, eyes markedly injected. Tongue dry and red and pointed. Epigastric pain and nausea very marked. At 10 p.m. he had a profuse haemorrhage from the nose. No urine passed all day.

22nd July.—Patient had a bad night, is very distressed and restless. Urine suppressed. Jaundice is now evident in the skin and sclerae. Hiccup very troublesome. Headache and loin pains are severe. Respirations, Cheyne-Stokes. At 11 a.m. he vomited 10 ounces of black vomit. Delirium and convulsions came on. A second profuse haemorrhage from the nose occurred at 3 p.m. Convulsions became continuous and death took place at 4.30 p.m.

Post-Mortem Examination

Autopsy was performed 16 hours after death.

Rigor mortis present. Skin and sclerae stained a deep yellow. Genital organs cyanosed. Petechial haemorrhages in skin of neck and chest.

Brain.—Congested. Vessels engorged.

Spinal cord.—Congested.

Membranes.—Congested. Vessels congested.

Heart.—Pale and flabby. Haemorrhages present on the external surface of the left ventricle and auricle. Valves showed old endocarditis. Weight, 11 ounces.

Large vessels.—Normal.

Lung, right.—Very congested at base.

Lung, left.—Very congested at base.

Pleurae.—No adhesions. Some pleural effusion present.

Pericardium.—Contained 1 ounce of fluid. Minute haemorrhages present on inner surface.

Larynx and trachea.—Congested.

Peritoneum.—Normal.

Stomach.—Contents: 3 ounces of black fluid. Mucous membrane congested. Rugae swollen and thrown into corrugations. Sub-mucous haemorrhages present at the cardiac and pyloric ends.

Small intestine.—Duodenum congested. Sub-mucous haemorrhages present in its entire length. Jejunum also congested, with sub-mucous haemorrhages. Ileum congested and haemorrhages present. Contents dark, tarry fluid.

Large intestine.—Congested. Patches of haemorrhage present. Contents, black, tarry fluid.

Helminths.—Ascarides present.

Liver.—Adherent to diaphragm. Yellow in colour. Friable and greasy on section. Haemorrhages seen in the substance as well as under capsule. Weight, 54 ounces.

Gall bladder.—Intensely congested.

Pancreas.—Normal. Weight, 4 ounces.

Spleen.—Congested. Slightly enlarged. Soft. Weight, 9 ounces.

Kidney, right.—Congested. Capsule strips easily. No haemorrhages. Weight, 7 ounces.

Kidney, left.—Some appearance as the right. Weight, 7 ounces.

Suprarenal capsules.—Normal.

Lymphatic system.—Normal.

Bladder.—Contracted. Contained two teaspoonfuls of turbid urine. Albuminous on examination.

Laboratory Report

Microscopic examination:

Blood smears show the presence of the *Paraplasma flavigenum.*

Liver.—Advanced fatty degeneration. Normal arrangement of the lobules

distorted. Portal spaces infiltrated with small round cells. Organ engorged. Several small haemorrhages.

Kidney.—Epithelium of the convoluted tubules degenerated. Cells swollen and granular. Lumen of tubules filled with granular débris and hyaline casts. Minute haemorrhages present.

Stomach.—Mucosa swollen, minute haemorrhages present.

Spleen.—Congested.

Case No. 9. L. 39

Sex: Female.
Age: 24 years.
Nationality: Syrian.
Occupation: Trader.
Date of admission: 21st July, 1913.
Date of discharge: 12th August, 1913.
Diagnosis: Yellow fever.

History.—Patient was one of the contacts removed from the house in which Case No. 8 had occurred. She was removed on the 20th, with the other contacts, to the Isolation Hospital. She felt ill the same night, complaining of feeling chilly and of a very severe frontal headache. She had a restless night. Patient was sent to the Lagos Hospital by the Senior Sanitary Officer on the 21st.

On admission.—Patient had a very anxious and distressed appearance. Face was flushed, eyes shining and watery, conjunctivae injected and red. Temperature was 102·4°, pulse rate 100 per minute. Respirations hurried.

Alimentary system.—Gums were swollen and red. Tongue, furred dorsum, red tip and edges. Liver was normal, no tenderness. Spleen also normal, no tenderness. Epigastrium was tender on pressure and uncomfortable. Nausea was present. Bowels had been opened once.

Circulatory system.—Heart sounds were normal. Pulse 100 per minute. Low tension.

Respiratory system.—Respirations were hurried. Lungs normal.

Nervous system.—Severe frontal headache complained of. Orbital pains also present. Severe aching pains in the loins, and in the lumbar muscles and muscles of the extremities.

Urinary system.—Patient passed 6 ozs. of urine at 2 p.m. Urine examination: Very cloudy. Acid reaction. Sp. gr. 1030. Albumen present. Tube casts present.

Other systems.—Skin was very dry. Conjunctivae were very injected and red.

Blood examination.—No malaria parasites were found. Small ring-shaped bodies with chromatin seen in several red corpuscles. Seidelin's bodies. Pigmented leucocytes. Leucocyte count: Polymorphonuclear, 75·5 per cent.; mononuclear, 6 per cent., lymphocytes, 15 per cent.; eosinophil, 3·5 per cent.

12 noon. Temperature 98·6°, pulse 80.

4 p.m. Temperature 102°, pulse 72.

8 p.m. Temperature 100·6°, pulse 70.

10 p.m. Patient very distressed, skin very dry, no sweating. No urine passed since 2 p.m. Nausea present, also epigastric pain and discomfort.

22nd July—

12 a.m. Temperature 101·4°, pulse.

4 a.m. Temperature 100·2°, pulse 70.

8 a.m. Temperature 100·2°, pulse 72.

Patient had a quiet night, urine passed. No vomiting. Headache still severe, also the lumbar and muscle pains. Conjunctivae still injected.

8 a.m. Urine examination : Acid reaction. Sp. gr. 1025. Albumen present.

12 noon. Temperature 101·2°, pulse 68.

4 p.m. Temperature 102·2°, pulse 60.

8 p.m. Temperature 101·2°, pulse 66.

10 p.m. Patient vomited 4 ozs. greenish fluid with dark débris. Headache much less. Urine passed. Examination : Acid. Sp. gr. 1025. Albumen present. Bowels opened three times.

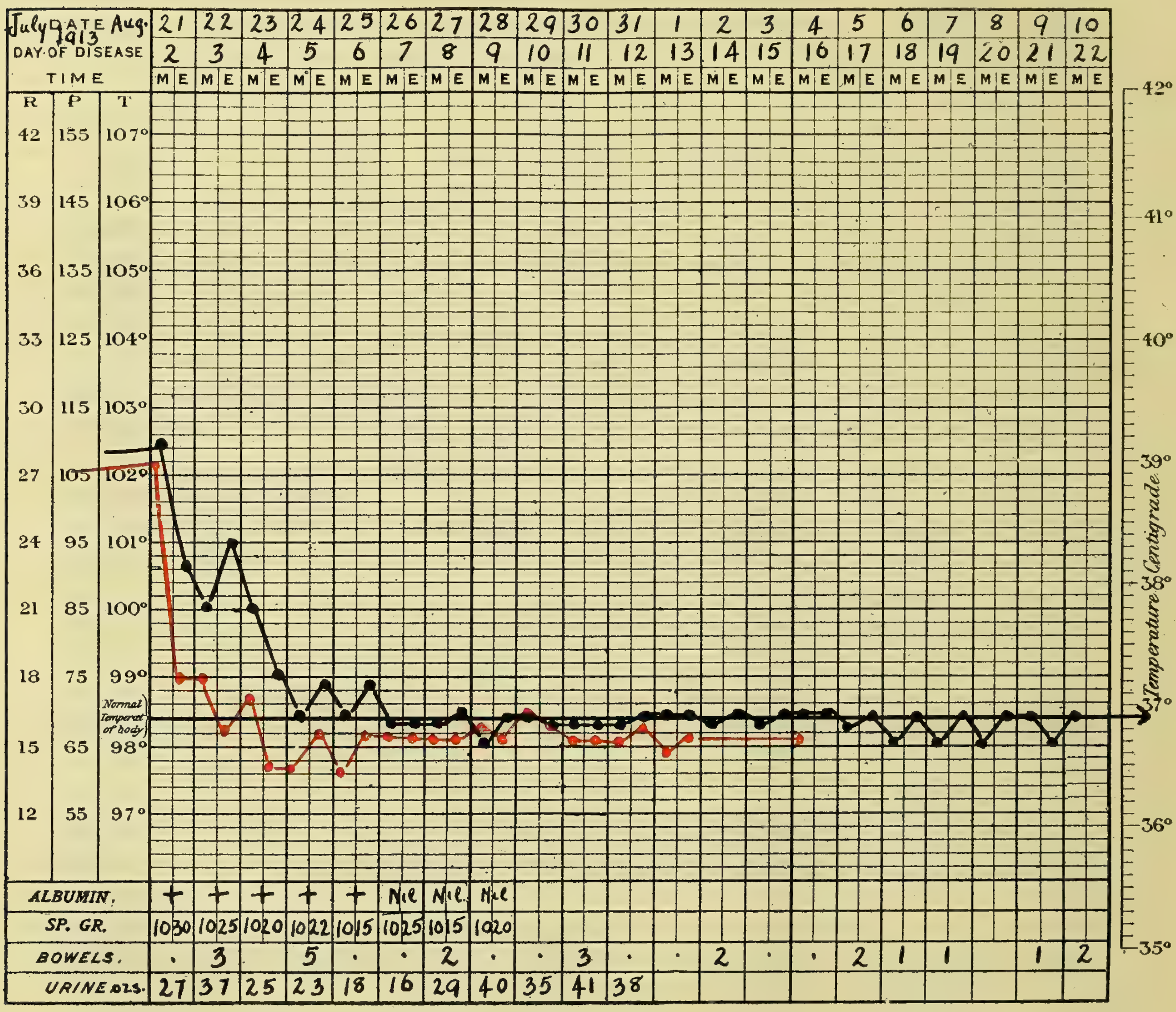


Chart 9

23rd July—

12 a.m. Temperature 100·2°, pulse 70.

4 a.m. Temperature 100·2°, pulse 65.

8 a.m. Temperature 100·2°, pulse 70.

Patient had a good night, no vomiting. Headache now very much less, eyes still injected. Urine passed. Examination : Acid. Sp. gr. 1020. Albumen present.

12 noon. Temperature 99·8°, pulse 62.

4 p.m. Temperature 99·8°, pulse 65.

8 p.m. Temperature 99°, pulse 60.

24th July—

12 a.m. Temperature 98·8°, pulse 62.

4 a.m. Temperature 98·8° pulse 56.

8 a.m. Temperature 98·4°, pulse 60.

Patient passed a very good night, slept well, no nausea or vomiting. All nourishment taken. Bowels moved five times after the calomel given the previous night. Passed two tape worms (*T. solium*). Urine examination: Acid reaction. Sp. gr. 1022. Albumen present.

12 noon. Temperature 98·6°, pulse 62.

4 p.m. Temperature 98·8°, pulse 68. Urine examination: Acid. Sp. gr. 1020. Albumen present, slight. Sclerae now yellow.

8 p.m. Temperature 98·6°, pulse 70.

25th July—

12 a.m. Temperature 98·6°, pulse 72.

8 a.m. Temperature 98·4°, pulse 60.

Patient had a very good night, slept well. No headache or pains. Appetite returning. Urine examination: Acid reaction. Sp. gr. 1015. Albumen present, slight.

12 noon. Temperature 98°, pulse 64.

4 p.m. Temperature 98·6°, pulse 70.

8 p.m. Temperature 98·4°, pulse 70.

26th July—

8 a.m. Temperature 98·2°, pulse 70.

Patient had a very good night, slept well. Now feels very much better, no headache, or pains. Sclerae now very yellow. Skin also tinged. Urine passed. Examination: Acid. Sp. gr. 1025. No albumen. Bile present.

12 noon. Temperature 98·6°, pulse 72.

4 p.m. Temperature 98·6°.

8 p.m. Temperature 98°, pulse 70.

27th July—

8 a.m. Temperature 98·6°, pulse 70.

Patient doing well, had a good night. Appetite good. Bowels opened. Urine examination: Acid. Sp. gr. 1015.

12 noon. Temperature 98·8°.

4 p.m. Temperature 98°, pulse 70.

8 p.m. Temperature 98·4°, pulse 72.

28th July—

8 a.m. Temperature 98°, pulse 70.

Patient doing well, had a good night. Urine examination: Acid. Sp. gr. 1020. No albumen. Bile.

12 noon. Temperature 98·4°.

8 p.m. Temperature 98°, pulse 70.

29th July—

8 a.m. Temperature 98·4°, pulse 72.

Patient doing well. Yellow colouration not so marked.

12 noon. Temperature 98·4°.

8 p.m. Temperature 98°, pulse 72.

30th July—

8 a.m. Temperature 98°, pulse 70.

Patient convalescent. Appetite good. Yellow colour disappearing. Urine normal.

12 noon. Temperature 98°.

8 p.m. Temperature 98·6°, pulse 70.

31st July—

8 a.m. Temperature 98·2°, pulse 70.

Patient well. Urine normal. Bowels opened.

12 noon. Temperature 98°.

8 p.m. Temperature 98·4°, pulse 75.

Patient continued to do well, and was discharged cured of the disease on the 12th August.

She was re-admitted for treatment for tape worms, and passed two more (*T. solium*).

Case No. 10. L. 40.

Sex : Male.

Age : 29 years.

Nationality : Negro, Yoruba tribe.

Occupation : Labourer.

Date of admission : 21st July, 1913.

Date of discharge : 12th August, 1913.

Diagnosis : Yellow fever.

History.—Patient states that on the night of the 18th July he had a feeling of chilliness with severe headache and fever. He had a bad night and no sleep. Next day he felt very much worse and kept to his bed. On the 20th he was much the same, headache very severe and aching pains in the back and extremities. On the morning of the 21st he went to Iddo station to go to his home at Offa, but was seen by the Medical Officer examining the trains and found to have a temperature of 104°, and was sent to the hospital.

On admission.—Patient appeared very ill, respirations were hurried. Conjunctivae were injected and very red, eyes shining and watery. Complained of severe frontal headache and aching pains in the back and limbs. Temperature on admission was 102°, pulse rate 96 per minute.

Alimentary system.—Patient complains of loss of appetite, bowels have been constipated for the past two days. Tongue is dry and pointed, with white dorsum and red tip and edges. Liver dullness is normal, and there is no tenderness on palpation. Spleen enlarged below the costal margin, no tenderness on palpation. Epigastric pain and discomfort are present, increased on pressure. Gums are swollen and red.

Circulatory system.—Heart sounds were normal. Pulse 96 per minute, low tension.

Respiratory system.—Respirations were hurried, 40 per minute. Lungs normal.

Nervous system.—Severe frontal headache. Aching pains in the back and extremities. Reflexes normal.

Urinary system.—Patient passed no urine from the time of his admission until next day. Examination : Acid reaction. Sp. gr. 1035. Albumen present. High percentage.

Blood examination.—Few malaria parasites present. Pigmented leucocytes present. Differential count : Polymorphonuclear, 78·5 per cent. ; mononuclear, 5 per cent. ; lymphocytes, 13·5 per cent. ; eosinophil, 3 per cent.

At 9 p.m. temperature rose to 105°, pulse rate 90. Patient was semi-delirious. No urine passed. No vomiting.

22nd July.—Patient had a bad night, did not sleep, and was very restless. Temperature fell, and at 8 a.m. was 101·4°, pulse 70. Passed urine at 5 a.m., 6 ozs.

Conjunctivae very injected. Headache and lumbar pains still severe. Temperature at 8 p.m. was 99·2°, pulse 64.

23rd July.—Temperature at 8 a.m. was 98·2°, pulse 62.

Patient had a better night and is feeling much improved. Urine has increased in quantity and still contains albumen. Bowels opened. Headache and loin pains much lessened in severity. Conjunctivae not so injected.

24th July.—Patient is much improved and had a good night. Headache and pains are nearly gone. Urine passed more freely but still contains albumen. Sclerae are tinged with yellow. Temperature at 8 a.m. was 97·8°, pulse 69, and at 8 p.m. was 98·4, pulse 72.

Patient continued to do well. Urine became normal in quantity, and the albumen gradually lessened and disappeared on the 27th July, bile making its appearance. Sclerae became very yellow and the jaundice then gradually cleared up and disappeared on the 8th August. Appetite returned and bowels were regular. The patient was discharged cured on the 12th August.

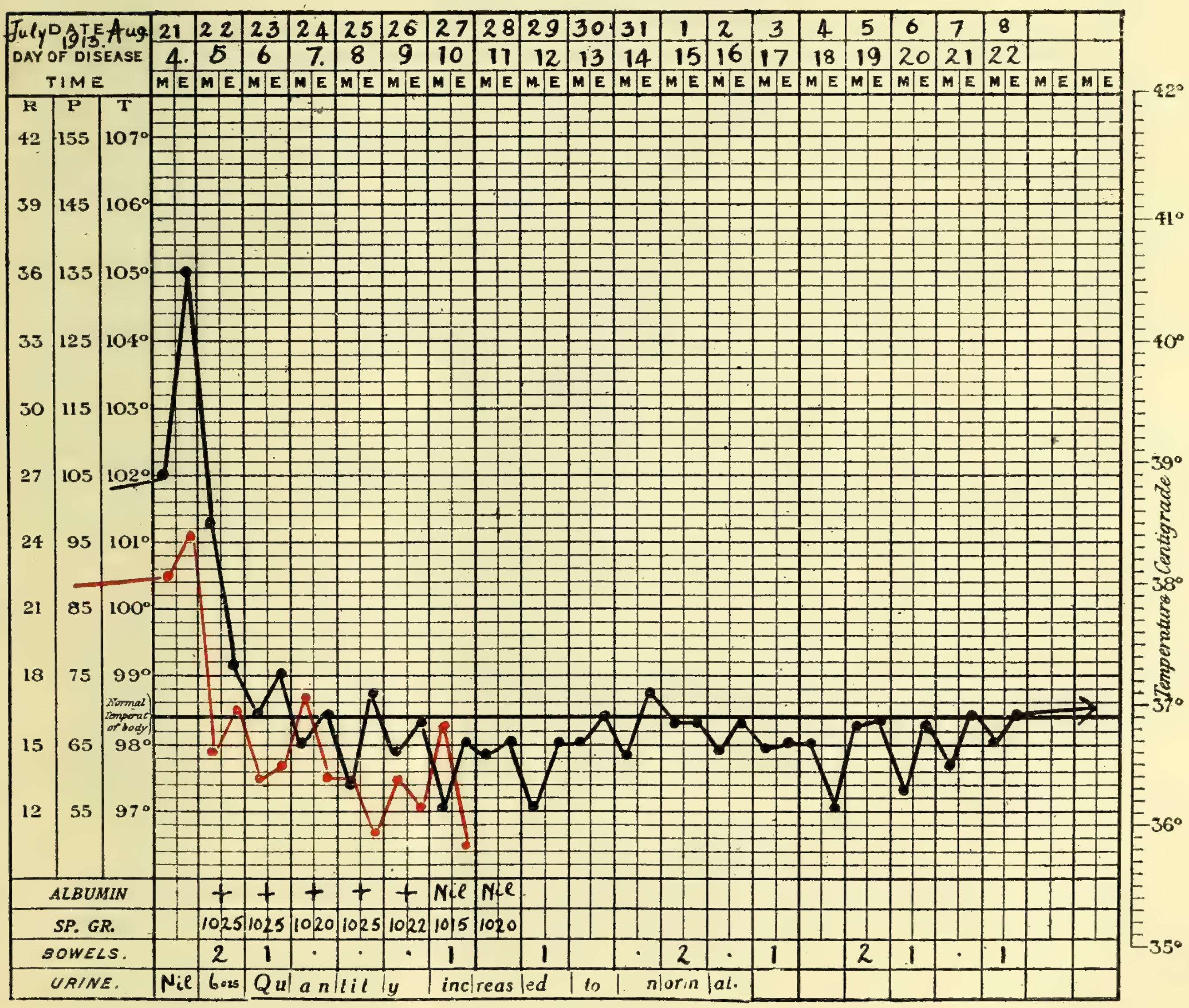


Chart 10

Case No. 11. L. 41

Sex: Male.
Age: 35 years.
Nationality: Syrian.
Occupation: Trader.
Date of admission: 25th July, 1913.
Date of death: 28th July, 1913.
Diagnosis: Yellow fever.

History.—Patient was admitted into hospital at 9 p.m. on the 25th July from the Isolation Hospital, where he had been under observation from the 20th. He was one of the occupants of the house in which Case No. 8 had occurred, and had been removed with the other contacts on the 20th. On the morning of the 24th he complained of not feeling well and that he had a severe headache and aching pains in the back and limbs. In the evening his temperature rose and he had vomiting, bilious in character. He had a restless night and was much worse next day, and was sent to the Lagos hospital.

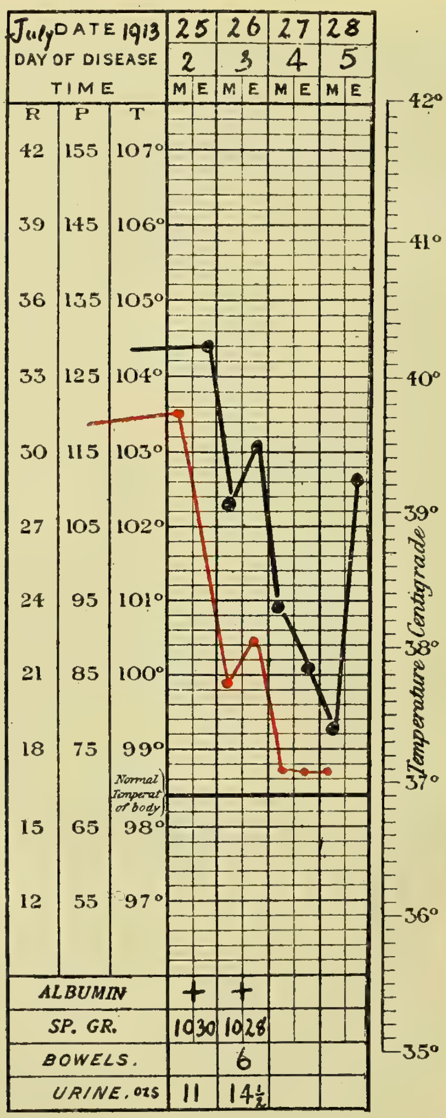


Chart 11

On admission.—Patient was very distressed, respirations were hurried. Face was flushed, eyes shining and bright. Conjunctivae were very injected and red. Temperature 104·6°, pulse rate 120 per minute.

Alimentary system.—Appetite lost. Bowels constipated. Tongue dry and pointed, with white dorsum and red tip and edges. Liver was normal, no tenderness. Spleen was enlarged and palpable, no tenderness. Nausea was present, with epigastric pain and discomfort, which increased on pressure.

Circulatory system.—Heart sounds normal. Pulse 120 per minute.

Respiratory system.—Lungs normal. Respirations hurried.

Urinary system.—Patient passed 2 ozs. of urine after admission. Examination: Acid reaction. Sp. gr. 1030. Albumen present, high percentage.

Blood examination.—No malaria parasites present. *Paraplasma flavigenum* present. Pigmented leucocytes present. Differential count: Polymorphonuclear, 76 per cent.; mononuclear, 7 per cent.; lymphocytes, 13 per cent.; eosinophil, 4 per cent.

Temperature rose at 10 p.m. to 104·4°, pulse rate 112.

26th July.—Patient had a bad night, very restless. Complained of severe frontal headache and pains in the loins. At 8 a.m. temperature was 102·4°, with a pulse rate of 90. Had an attack of vomiting, bilious in character. Passed 14 ozs. of urine, which on examination was found to be highly albuminous. Temperature rose in the afternoon and at 8 p.m. it was 103·2°, with a pulse of 84. Patient is looking very ill. Conjunctivae very injected and red. Epigastric pain and discomfort with nausea present. Vomited several times during the afternoon.

27th July.—Patient had a bad night, very restless. No urine passed at all. Temperature at 8 a.m. was 100·8°, pulse rate 72. Vomited at 8.30 a.m. a clear fluid with chocolate-coloured débris. Sclerae are yellow. Nausea still present with epigastric discomfort.

28th July.—Patient passed a quiet night. No urine passed for the past twenty-four hours. Temperature at 8 a.m. was 99·4°, pulse rate 72. Temperature began to rise in the afternoon and at 8 p.m. was 102·6°. Patient began to get comatose, and death occurred quietly at 8.15 p.m. Skin deeply jaundiced.

Post-mortem Notes

Autopsy was performed 12 hours after death.

Rigor mortis present.

Skin and sclerae stained an intense yellow. Genital organs cyanosed.

Brain.—Appeared normal.

Spinal cord.—Normal.

Membranes.—Congested.

Pericardium.—Showed old adhesions. Contained 1 oz. of fluid.

Heart.—Pale and flabby. Minute haemorrhages seen on the surface of the ventricles. Valves normal. Sub-endocardial haemorrhages well marked in the left ventricle. Weight 8½ ozs.

Large vessels.—Normal.

Lung, right.—Very congested, particularly at base.

Lung, left.—Same as right.

Pleurae.—Adhesions present in right side, left side normal. Some effusion present.

Larynx and trachea.—Normal.

Peritoneum.—Normal.

Stomach.—Contents 10 ozs. of black fluid. Mucous membrane very congested. Rugae swollen and prominent. Submucous haemorrhages well marked at the cardiac and pyloric ends. Large extensive haemorrhage along the greater curvature.

Small intestine.—Duodenum intensely congested. Numerous submucous

haemorrhages present. Contained black fluid similar to that in the stomach. Jejunum also intensely congested and minute submucous-haemorrhages present. Ileum very congested along its entire length to within two feet of the ileo-caecal valve.

Large intestine.—Mucous membrane congested and thickened. Contents a brown fluid.

Helminths.—Numerous ascarides. Two tape worms (*T. saginata*) also found.

Liver.—Pale yellow in appearance with patches of hyperaemia. Well-marked subcapsular haemorrhages. On section, greasy and very friable. Weight 46 ozs.

Gall bladder.—Normal.

Pancreas.—Normal. Weight 5 ozs.

Spleen.—Enlarged and tough. Congested. Weight 14½ ozs.

Kidney, right.—Very congested. Enlarged. Capsule strips easily. On section, cortex congested, medullary portion showing haemorrhages. Weight 6½ ozs.

Kidney, left.—Same as the right. Weight 7 ozs.

Suprarenal capsules.—Normal appearance.

Lymphatic system.—Normal.

Bladder.—Contracted. Contained 1 oz. of dark, turbid urine. Acid reaction and highly albuminous.

Laboratory Report

Microscopic

Blood smears contained the *Paraplasma flavigenum.*

Histological

Liver.—Profound fatty degeneration present. Great increase of fibrous tissue. Normal structure of organ practically obliterated. The few cells clearly visible contained fatty globules and vacuoles.

Kidney.—Hyperaemia and a number of haemorrhages present. Cells of the convoluted tubules were swollen and granular. Tubules denuded in places, and filled with granular and hyaline débris.

Spleen.—Engorged.

Stomach and intestines.—Ecchymoses present. Vessels engorged. Epithelium swollen and granular.

Case No. 12. L. 42

Sex: Male.
Age: 26 years.
Nationality: Negro, Krooboy.
Occupation: Servant.
Date of admission: 25th July, 1913.
Date of discharge: 12th August, 1913.
Diagnosis: Yellow fever.

History.—Patient states that he got ill this morning, felt chilly and had a severe headache. He also had pains in the back and limbs. No vomiting, but nausea is present. He was sent into the hospital and admitted at 11 a.m.

On admission.—Patient was very distressed and looked ill. Complained of severe frontal headache and pains in the loins and muscles of the extremities. Tem-

perature on admission was 101°, pulse rate 100 per minute. Conjunctivae were very injected and red.

Alimentary system.—Appetite lost. Bowels constipated. No vomiting, but nausea present. Tongue furred, with tip and edges clean and red. Liver normal, no tenderness. Spleen is palpable and tender. No epigastric pain.

Circulatory system.—Heart sounds were normal. Pulse was 100.

Respiratory system.—Lungs were normal. Respirations hurried, 30 per minute.

Nervous system.—Severe frontal headache. Aching pains in the loins and extremities. Reflexes were normal.

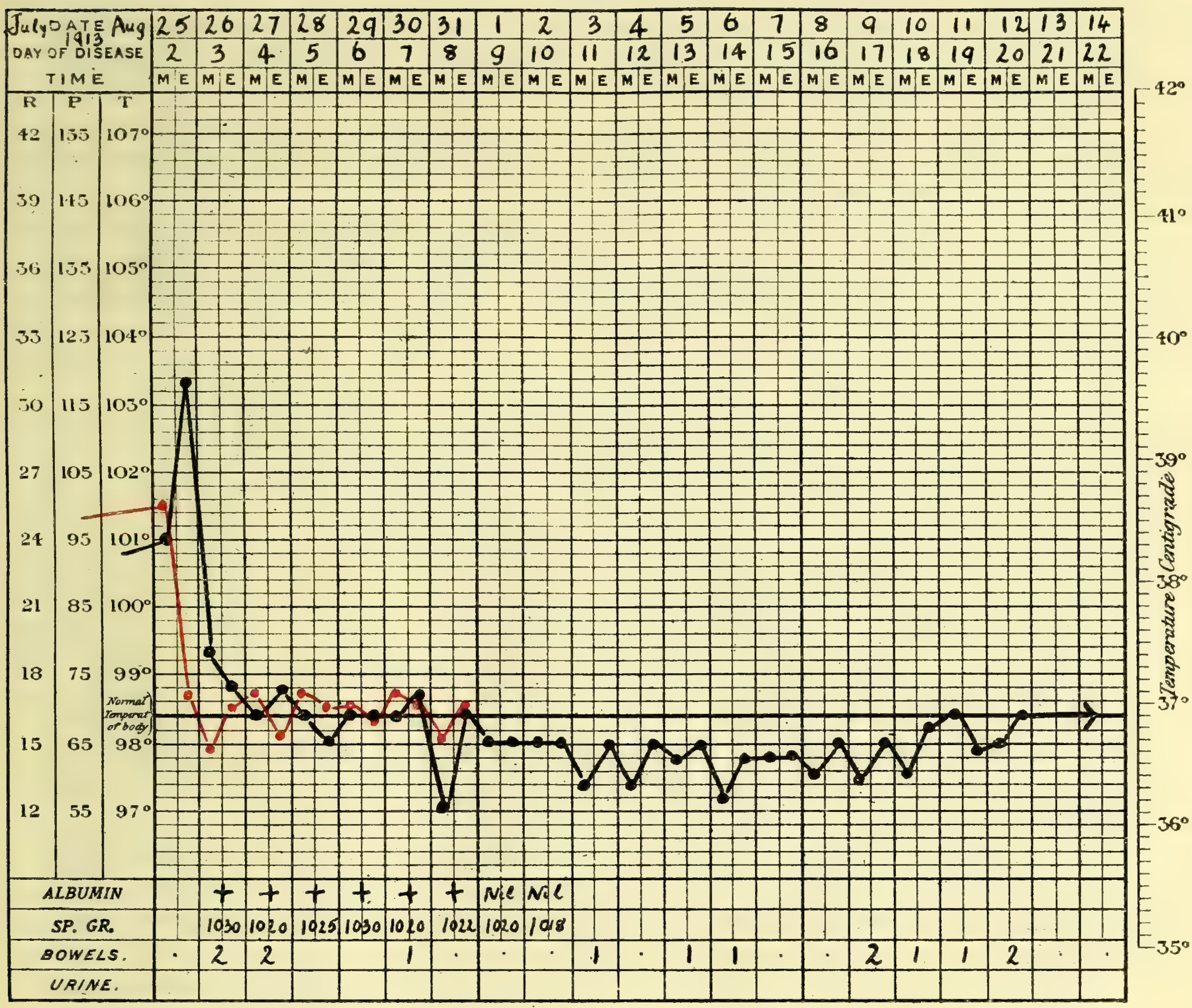


Chart 12

Urinary system.—Patient passed no urine from the time of his admission until next morning. Urine examination: Acid reaction. Sp. gr. 1030. Albumen present.

Blood examination.—No malaria parasites present. *Paraplasma flavigenum* present. Pigmented leucocytes present. Differential count: Polymorphonuclear, 79·5 per cent.; lymphocytes, 16·5 per cent.; mononuclear, 3 per cent.; eosinophil, 1 per cent. Temperature rose towards evening, being 102·6°, with pulse rate of 80, and at 8 p.m. 103·4°, pulse rate 72.

26th July.—Patient had a bad night, did not sleep. Headache severe. Conjunctivae very injected and red. Tongue pointed and red. Bowels opened. Nausea present, but no vomiting. Urine passed, but the amount is diminished. Epigastrium is uncomfortable.

27th July.—Patient had a better night. Conjunctivae not so injected. Headache still present, but not so severe. Urine passed in larger quantity. On examination: Acid reaction, sp. gr. 1020, and albumen present. Temperature has fallen. Pulse still slow. Bowels opened.

28th July.—Patient had a fair night. Had several attacks of vomiting, bilious in character. Headache is much less as well as the lumbar pains. Urine still contains albumen, but lessened in amount.

29th July.—Patient doing well, had a good night. Sclerae are tinged with yellow. Urine increased in quantity, but albumen still present. Appetite is improving. Nausea is passing off.

30th July.—Patient much improved and doing well. Appetite improved. Bowels regular. Urine increased in quantity, but still contains a slight amount of albumen. Sclerae very yellow.

Patient continued to do well. Albumen disappeared from the urine on the 1st August and bile appeared. Sclerae remained yellow until the 8th August and then cleared up. Patient made an uneventful recovery, and was discharged cured on the 12th August.

Case No. 13. L. 43

Sex: Male.
Age: 36 years.
Nationality: Negro, Yoruba tribe.
Occupation: Police-constable.
Date of admission: 26th July, 1913.
Date of discharge: 18th August, 1913.
Diagnosis: Yellow fever.

History.—Patient states that he has not been feeling well for the past three days, suffering from a headache, with aches and pains in the limbs and fever at night. Bowels were constipated at the time. Yesterday, the 25th, he felt very ill and reported sick, and was sent to the hospital.

On admission.—Patient looked ill and distressed, with hurried respirations. Complained of severe frontal headache and pains in the loins and extremities. Skin dry and hot. Eyes shining and conjunctivae injected and red. Temperature on admission was 104°, pulse rate 74 per minute.

Alimentary system.—Appetite lost. Bowels constipated. Tongue pointed, with red tip and edges, dorsum furred. Liver normal. Spleen palpable. No vomiting, but nausea present. Epigastrium tender on pressure.

Circulatory system.—Heart sounds normal. Pulse rate 74.

Respiratory system.—Lungs normal. Respirations hurried.

Nervous system.—Severe frontal headache. Aching pains in the loins and limbs.

Urinary system.—Urine passed on admission. Urine examination: Acid reaction. Sp. gr. 1030. Albumen present, slight.

Blood examination.—Malaria parasites present. Subtertian not numerous. Pigmented leucocytes present. Small ring-shaped bodies present in many of the red cells. Leucopenia present. Leucocyte count: Polymorphonuclear, 78 per

cent. ; lymphocytes, 16·4 per cent. ; mononuclear, 5 per cent. ; eosinophil, 0·6 per cent.

Other systems.—Skin very hot and dry. Conjunctivae injected and very red. Eyes shining. Temperature on admission was 104°, pulse 74 per minute.

12 noon. Temperature 103·6°, pulse 70.

4 p.m. Temperature 103·4°, pulse 72.

8 p.m. Temperature 102·2°, pulse 70.

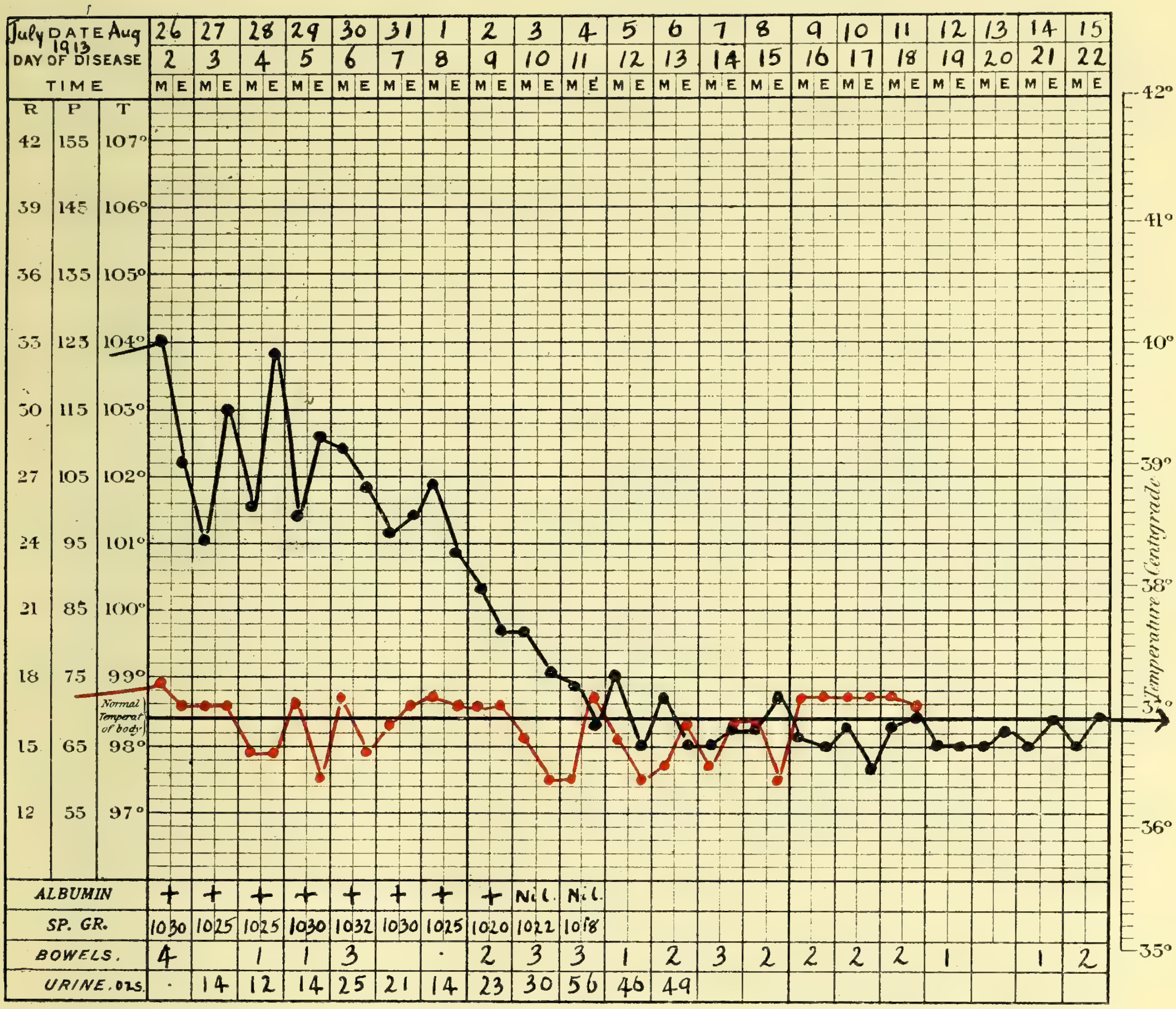


Chart 13

27th July—

12 a.m. Temperature 101°, pulse 68.

4 a.m. Temperature 100°, pulse 72.

8 a.m. Temperature 101°, pulse 70.

Patient had a fair night, headache still severe. Bowels moved four times after aperient. Urine examination : Acid reaction. Sp. gr. 1025. Albumen present, increased.

12 noon. Temperature 103·4°, pulse 68.

4 p.m. Temperature 103·6°, pulse 66.

8 p.m. Temperature 103°, pulse 70.

28th July—

12 a.m. Temperature 103·2°, pulse 66.

4 a.m. Temperature 101·8°, pulse 60.

8 a.m. Temperature 101·4°, pulse 64.

Patient had a better night. Headache still severe. Tongue pointed and red. Nausea present, no vomiting present. Urine examination: Acid reaction. Sp. gr. 1025. Albumen present. Conjunctivae injected.

12 noon. Temperature 102°, pulse 66.

4 p.m. Temperature 103°, pulse 60.

8 p.m. Temperature 103·8°, pulse 64.

29th July—

12 a.m. Temperature 101·2°, pulse 70.

4 a.m. Temperature 101·6°, pulse 72.

8 a.m. Temperature 101·4°, pulse 70.

Patient had a better night. Slept more. Bowels moved once. Headache still severe. Conjunctivae injected. Urine examination: Acid reaction. Sp. gr. 1030. Albumen present.

12 noon. Temperature 103°, pulse 64.

4 p.m. Temperature 101·8°, pulse 64.

8 p.m. Temperature 102·6°, pulse 60.

30th July—

12 a.m. Temperature 102°, pulse 68.

4 a.m. Temperature 101·4°, pulse 72.

8 a.m. Temperature 102·4°, pulse 72.

Patient had a bad night, did not sleep well. Headache very severe, and also the pains in the muscles. Urine examination: Acid reaction. Sp. gr. 1032. Albumen present.

12 noon. Temperature 102·4°, pulse 70.

4 p.m. Temperature 101·4°, pulse 70.

8 p.m. Temperature 101·8°, pulse 64.

31st July—

12 a.m. Temperature 101°, pulse 66.

4 a.m. Temperature 101·4°, pulse 70.

8 a.m. Temperature 101·2°, pulse 68.

Patient had a better night. Headache still severe. Eyes injected. Urine examination: Acid reaction. Sp. gr. 1030. Albumen present.

12 noon. Temperature 101°, pulse 60.

4 p.m. Temperature 102°, pulse 60.

8 p.m. Temperature 101·4°, pulse 70.

1st August—

12 a.m. Temperature 101°, pulse 68.

4 a.m. Temperature 101·4°, pulse 72.

8 a.m. Temperature 101·8°, pulse 72.

Patient had a good night, slept well. Bowels opened and urine passed freely. Urine examination: Acid reaction. Sp. gr. 1025. Albumen present, slight.

12 noon. Temperature 102°, pulse 64.

4 p.m. Temperature 102·6°, pulse 60.

8 p.m. Temperature 100·8°, pulse 70.

2nd August—

12 a.m. Temperature 100·4°, pulse 72.

4 a.m. Temperature 100·4°, pulse 70.

8 a.m. Temperature 100·2°, pulse 70.

Patient doing well, had a very good night. Sclerae now yellow. Urine examination: Acid reaction. Sp. gr. 1020. Albumen present, cloud.

12 noon. Temperature 100·6°, pulse 68.
4 p.m. Temperature 99·6°, pulse 70.
8 p.m. Temperature 99·8°, pulse 66.

3rd August—

12 a.m. Temperature 99°, pulse 72.
8 a.m. Temperature 98·8°, pulse 60.

Patient very well. Good night. Bowels opened. Urine passed freely. Examination: Acid reaction. Sp. gr. 1022. No albumen. Sclerae very yellow.

12 noon. Temperature 98·2°.
4 p.m. Temperature 99°, pulse 72.
8 p.m. Temperature 98°.

Patient now continued to do well and make an uneventful recovery, and was discharged cured on the 18th August, 1913.

Case No. 14. L. 44

Sex: Male.
Age: 30 years.
Nationality: European, British.
Occupation: Bank accountant.
Date of admission: 26th July, 1913.
Date of discharge: 12th August, 1913.
Diagnosis: Yellow fever.

History.—Patient was one of the contacts removed from the house in which Case No. 7 had occurred, and had been in the isolation hospital from the 18th July. On the evening of the 25th, he felt ill and had a frontal headache and general aches and pains. Next morning he felt much worse and had pyrexia, so was sent into the Lagos Hospital by the Senior Sanitary Officer.

On admission.—Patient looked anxious and distressed. Face was flushed and eyes shining. Conjunctivae were injected and red. Respirations were hurried. Temperature was 101·2°, pulse rate 90 per minute.

Alimentary system.—Appetite lost. Bowels were constipated. Gums were red and swollen. Tongue was furred, with tip and edges clean and red. Liver was normal. Spleen was normal in size, but tender on pressure. Nausea present, epigastrium tender.

Circulatory system.—Heart sounds were normal. Pulse low tension, 90 per minute.

Respiratory system.—Lungs were normal. Respirations hurried.

Nervous system.—Severe frontal headache. Aching pains in the loins and limbs. Reflexes were normal.

Urinary system.—Patient passed 2 ozs. of urine on admission. High-coloured. Examination: Acid reaction. Sp. gr. 1025. No albumen present.

Blood examination.—No malaria parasites present. *Paraplasma flavigenum* present. Differential count: Polymorphonuclear, 80 per cent.; mononuclear, 2·5 per cent.; lymphocytes, 17 per cent.; eosinophil, 0·5 per cent.

In the afternoon the temperature rose to 102°, pulse 88. Conjunctivae were very red and injected. Severe frontal headache and loin pains complained of. Passed 16 ozs. of urine, high-coloured. Examination: Acid reaction. Sp. gr. 1025. Albumen present.

27th July.—Patient had a bad night, did not sleep and was restless. Headache severe, also loin and muscle pains. Passed 8 ozs. of urine at 8 a.m. Examination: Acid reaction, sp. gr. 1030, albumen present and increased in amount. Tempera-

ture at 8 a.m. was 101·4°, pulse 82. In the afternoon temperature rose, face was very flushed and conjunctivae very injected. Headache severe. Temperature at 8 p.m. was 100·6°, pulse rate 80. Urine examined at night showed increase of albumen.

28th July.—Patient passed a better night. Headache much less this morning. Loin pains also decreased. Temperature at 8 a.m. was 99·6°, pulse 72. Urine increased in amount, not up to normal. Albumen still present. Bowels opened. Temperature at 8 p.m. was 99°, pulse rate 64.

29th July.—Patient had a fair night. Headache and loin pains very much decreased. Urine has increased in quantity and still contains albumen. Sclerae are slightly tinged with yellow.

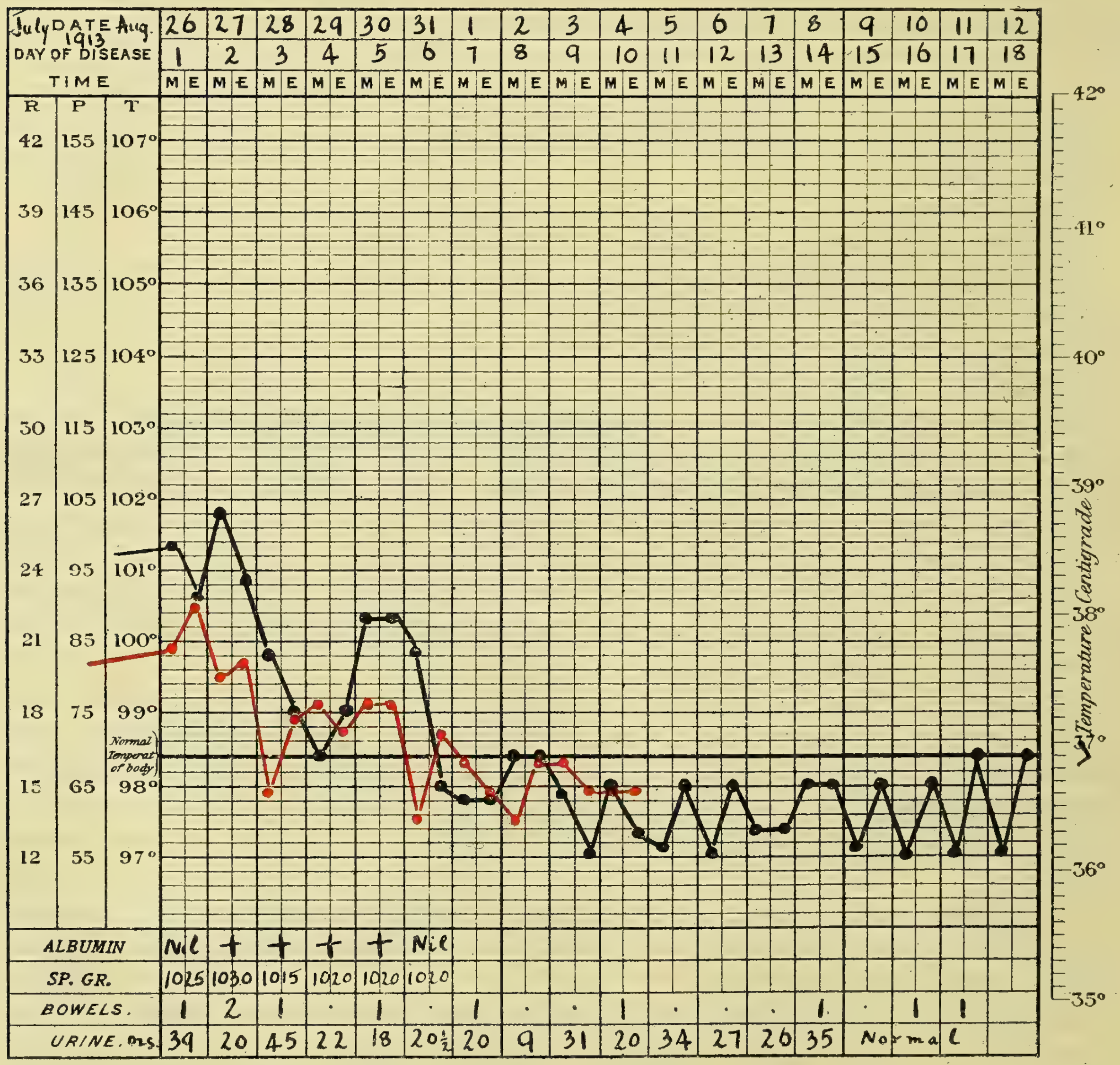


Chart 14

30th July.—Patient is very much better and had a fair night. Bowels opened. Headache has now disappeared. Loin pains are much less. Urine passed but still diminished. Albumen still present but lessened in amount. Sclerae yellow.

31st July.—Patient had a good night and is feeling better No headache or loin pains. Urine examination shows that the albumen has disappeared and bile is present. Sclerae are yellow. Temperature at 8 a.m. was 99·6°, pulse rate 72, and at 8 p.m. 97·8°, pulse rate 60.

1st August.—Patient doing well. Slept well. Skin is now jaundiced. Sclerae yellow. No headache or pains of any kind. Urine passed freely and there is no albumen. Appetite has returned and bowels are regular.

Patient continued to do well and made an uninterrupted recovery, and was discharged cured on the 12th August.

Case No. 15. L. 45

Sex: Male.
Age: 23 years.
Nationality: Negro, Beni tribe.
Occupation: Servant.
Date of admission: 28th July, 1913.
Date of discharge: 12th August, 1913.
Diagnosis: Yellow fever.

History.—Patient became ill yesterday, the 27th, with a very severe frontal headache, and had to go to bed. He also had chilly sensations and pains in the loins and extremities. He was sent to the hospital, and as his temperature was 100°, he was admitted.

On admission.—Patient was very distressed and anxious. Conjunctivae injected and red and he complained of severe frontal headache and aching pains in the loins and limbs.

Alimentary system.—Appetite lost. Bowels constipated. Tongue pointed, white dorsum with red tip and edges. Liver normal. Spleen normal, no tenderness. No epigastric pain or discomfort.

Circulatory system.—Heart sounds normal. Pulse 100 per minute.

Respiratory system.—Lungs normal. Respirations hurried.

Nervous system.—Severe frontal headache. Aching pains in the loins and extremities. Reflexes normal.

Urinary system.—Patient passed 4 ounces of urine on admission. Examination: Acid reaction. Sp. gr. 1030. No albumen.

Blood examination.—Ring forms of malaria parasites present. Pigmented leucocytes. *Paraplasma flavigenum* present. Differential count: Polymorphonuclear, 79 per cent.; mononuclear, 7·6 per cent.; lymphocytes, 13 per cent.; eosinophil, 0·4 per cent. Haemoglobin, 85 per cent.

29th July—

8 a.m. Temperature 100°, pulse rate 80.

Patient had a restless night, did not sleep. Headache still severe, aching pains in the extremities. Bowels opened. Urine passed, diminished in quantity. On examination: Acid reaction. Sp. gr. 1025. Albumen present.

8 p.m. Temperature 100°, pulse rate 70.

30th July—

8 a.m. Temperature 98·6°, pulse rate 64.

Patient had another restless night, did not sleep owing to the severe headache and pains in the loins and extremities. Conjunctivae very injected. Urine still lessened, albumen present on examination.

8 p.m. Temperature was 98·8°, pulse rate 60.

31st July—

8 a.m. Temperature was 98·4°, pulse 60.

Patient had a better night. Headache and pains are much less. Bowels

opened. Urine increased and on examination is acid in reaction. Sp. gr. 1020 Albumen still present.

8 p.m. Temperature 99°, pulse 60. Sclerae are now yellow.

1*st August*—

8 a.m. Temperature 98·8°, pulse 56.

Patient had a good night and feels much improved. Appetite has returned. Bowels regular. Headache and loin pains quite gone. Sclerae are still yellow. Urine examination: Acid reaction. Sp. gr. 1025. No albumen present. Bile present.

8 p.m. Temperature was 98·6°, pulse rate 64.

Patient continued to do well, jaundice deepened and gradually disappeared about the 8th August. Appetite returned. Bowels were regular. Urine became normal in quantity and patient made an uneventful recovery, and was discharged cured on the 12th August.

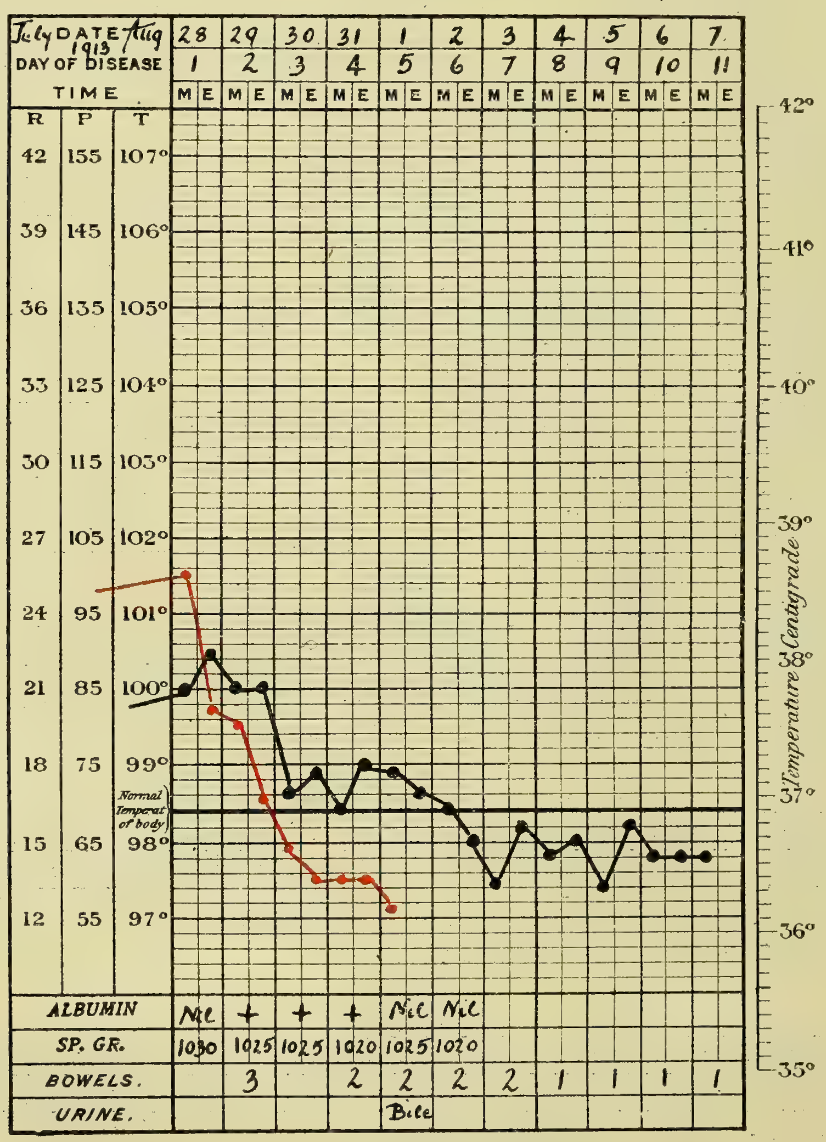


Chart 15

CASE No. 16. L. 46

Sex : Male.
Age : 26 years.
Nationality : Negro, Krooboy.
Occupation : Cook.
Date of admission : 28th July, 1913.
Date of discharge : 18th August, 1913.
Diagnosis : Yellow fever.

History.—Patient states that he became ill yesterday, the 27th, at night. The illness began with rigors, followed by fever. He also had a very severe headache and his bowels were constipated. He had no vomiting and no epigastric pains or discomfort. He was sent to the hospital for treatment.

On admission.—Patient looked ill and distressed, temperature being 103·4°, with a pulse of 128 per minute. He complained of severe headache and aching pains in the back.

Alimentary system.—Appetite lost. Bowels constipated. Tongue coated. Liver normal. Spleen also normal, no tenderness. No vomiting. No epigastric tenderness.

Circulatory system.—Heart sounds normal.

Respiratory system.—Lungs normal. Respirations hurried, 24 per minute.

Nervous system.—Severe frontal headache. Aching pains in the back and limbs. Reflexes normal.

Urinary system.—Patient said that his urine was less than usual. Very high-coloured. On examination : Acid reaction. Sp. gr. 1020. No albumen.

Blood examination.—Ring form of malaria parasites present. *Paraplasma flavigenum* also present. Differential count : Polymorphonuclear, 69 per cent. ; mononuclear, 7 per cent. ; lymphocytes, 21 per cent. ; eosinophil, 3 per cent.

Temperature rose to 102 at 8 p.m. with a pulse rate of 75 per minute.

29th July—

8 a.m. Temperature was 101·4°, pulse 115.

Patient had a fair night, bowels had been opened and urine passed freely but not up to the normal amount. On examination no albumen found.

At 8 p.m. temperature was 103° with pulse of 110.

30th July—

Temperature at 8 a.m. was 102°, pulse rate 100. Patient had a bad night and did not sleep. Bowels had been opened. Headache and loin pains severe. No vomiting. Temperature at 8 p.m. was 102° with a pulse rate of 75.

31st July—

Temperature at 8 a.m. was 101°, pulse rate 60.

Patient had a bad night, complained of severe headache and aching pains in the loins. Urine diminished but no albumen present. Temperature at 8 p.m. 101·4°, pulse rate 60.

1st August—

Temperature at 8 a.m. 100·2°, pulse rate 52.

Patient had a bad night, did not sleep. Complains of severe frontal headache and aching pains in the loins and extremities. Conjunctivae are very red and injected. Tongue pointed and red. Nausea present, with epigastric pain and discomfort. Urine passed but is diminished and high coloured. On examination : Acid reaction. Sp. gr. 1032. Albumen present.

Blood examination.—No malaria parasites present. *Paraplasma flavigenum* present. Leucopenia present.

Patient had been given quinine the first three days, hence the disappearance of the malaria.

Temperature at 8 p.m. was 101·4°, pulse rate 60.

2nd August.—Temperature at 8 a.m. 100·8°, pulse rate 56.

Patient had a bad night, very restless. Vomited several times, last specimen of vomit consisted of clear fluid with dark brown débris. Complains of severe headache and epigastric pain and discomfort. Urine is diminished and contains albumen in increased amount.

Temperature at 8 p.m. 100·8°, pulse rate 62.

3rd August.—Patient had a better night. No vomiting. Headache much less. Bowels opened. Urine still contains albumen. Temperature at 8 a.m. was 100·8°, pulse 60, and at 8 p.m. 100°, pulse rate 56.

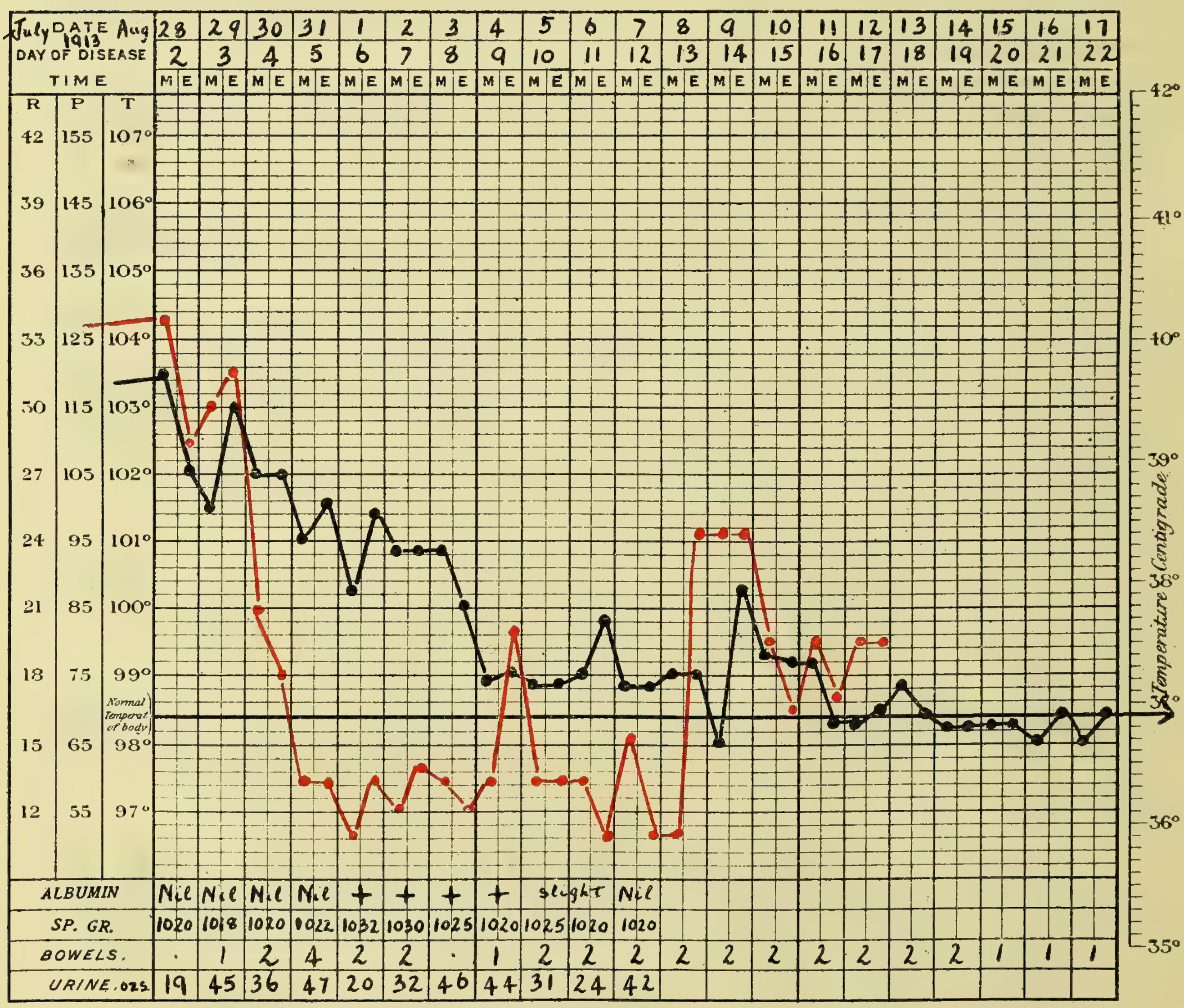


Chart 16

4th August.—Patient much better and had a good night. Headache and loin pains lessened. Sclerae are now yellow. Urine increased in amount. On examination: Acid reaction. Sp. gr. 1020. Albumen present but lessened.

Nausea slight, epigastric discomfort has now disappeared.

Patient continued to do well and improve daily. Appetite returned. Bowels became regular. Urine increased in quantity and the albumen disappeared on the 7th August and bile appeared in the urine. Jaundice deepened and then gradually disappeared on the 13th August, and the patient was discharged cured on the 18th August.

Case No. 17. L. 47

Sex: Male.
Age: 39 years.
Nationality: Negro, Yoruba tribe.
Occupation: Clerk, Government service.
Date of admission: 5th August, 1913.
Date of discharge: 14th August, 1913.
Diagnosis: Yellow fever.

History.—Patient states that his illness began on the 3rd inst. at 7 p.m. with a sense of chilliness, followed by headache and later by pyrexia. He took some quinine and an aperient and went to bed. He had a restless night and felt much worse next morning. He kept in bed all that day, suffering from severe frontal

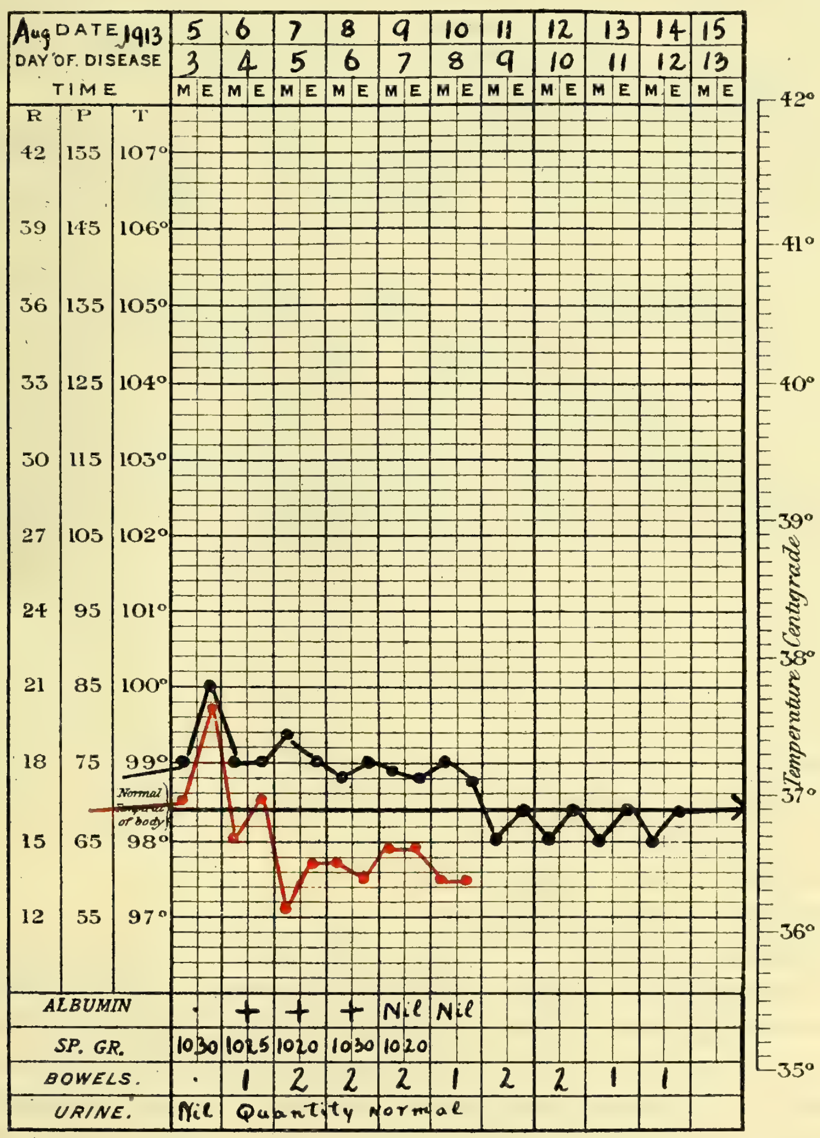


Chart 17

headache, aching pains in the loins and extremities, and high fever. The bowels were opened. He had no vomiting. He was seen by a Medical Officer next day and sent to hospital.

On admission.—Patient was sweating freely. Complained of severe frontal headache and pains in the loins and extremities. Conjunctivae were injected and red. Temperature was 99°, pulse rate 82 per minute.

Alimentary system.—Appetite lost. Bowels had been opened by an aperient. Tongue was furred on the dorsum with red tip and edges. No vomiting or nausea. Liver was normal. Spleen palpable.

Circulatory system.—Heart sounds were normal. Pulse was 82 per minute.

Respiratory system.—Lungs were normal.

Nervous system.—Severe frontal headache. Aching pains in the loins and extremities. Reflexes were normal.

Urinary system.—Urine was high coloured. Acid in reaction. Sp. gr. 1030. Albumen present.

Blood examination.—Few malaria parasites present. *Paraplasma flavigenum* present. Pigmented leucocytes present. Differential count: Polymorphonuclear, 76 per cent.; mononuclear, 4·6 per cent.; lymphocytes, 15·2 per cent.; eosinophil, 4·2 per cent.

6th August.—Patient had a fair night. No vomiting. Passed 18 ounces of urine. Examination: Acid reaction. Sp. gr. 1025. Albumen present. Headache not so severe. Loin pains also diminished. Sclerae are now yellow. Temperature was 99·4°, pulse rate 65.

7th August.—Patient had a good night. Urine passed in greater quantity, but still contains albumen. Jaundice very marked in the sclerae. Temperature at 8 a.m. 99°, pulse rate 68. At 8 p.m. it was 98·8°, with pulse of 56. Bowels opened.

8th August.—Patient had a good night. Appetite is improving. Bowels are regular and urine has increased in amount. On examination: Acid reaction. Sp. gr. 1030. Albumen has disappeared. Bile present. Sclerae very yellow. Temperature at 8 a.m. was 98·8°, pulse 60, and at 8 p.m. 99°, with pulse of 62.

9th August.—Patient is doing well. Appetite good and bowels regular. Headache and pains all quite gone. Temperature normal. Sclerae very yellow.

Patient continued to progress favourably and made an uneventful recovery. He was discharged cured on the 14th August, the jaundice having cleared up on the 12th.

Case No. 18. L. 51

Sex: Male.
Age: 21 years.
Nationality: Negro, Krooboy.
Occupation: Labourer.
Date of admission: 11th August, 1913.
Date of discharge: 26th August, 1913.
Diagnosis: Yellow fever.

History.—Patient states that he became ill yesterday, the 10th, the illness beginning with sensations of chilliness and heat. Later he had frontal headache and pains in the back and limbs. He had a bad night and feels very much worse this morning. Bowels were constipated, he had no vomiting, but nausea was present.

On admission.—Patient was admitted at 3 p.m. Temperature 102·4°, pulse rate 100. Complains of severe frontal headache and aching pains in the loins and

limbs. Respirations are hurried. Conjunctivae are injected and red. Eyes watery.

Alimentary system.—Gums are swollen and red. Tongue pointed, furred centre, edges are clean. Liver is normal. Spleen palpable, no tenderness. Nausea is present. No epigastric pain or discomfort. Bowels constipated.

Circulatory system.—Heart sounds are normal. Pulse 100 per minute.

Respiratory system.—Lungs normal. Respirations hurried.

Nervous system.—Severe frontal headache. Aching pains in the loins and extremities. Reflexes are normal.

Urinary system.—Urine is very high coloured. No deposit. Acid reaction. Sp. gr. 1015. Albumen present.

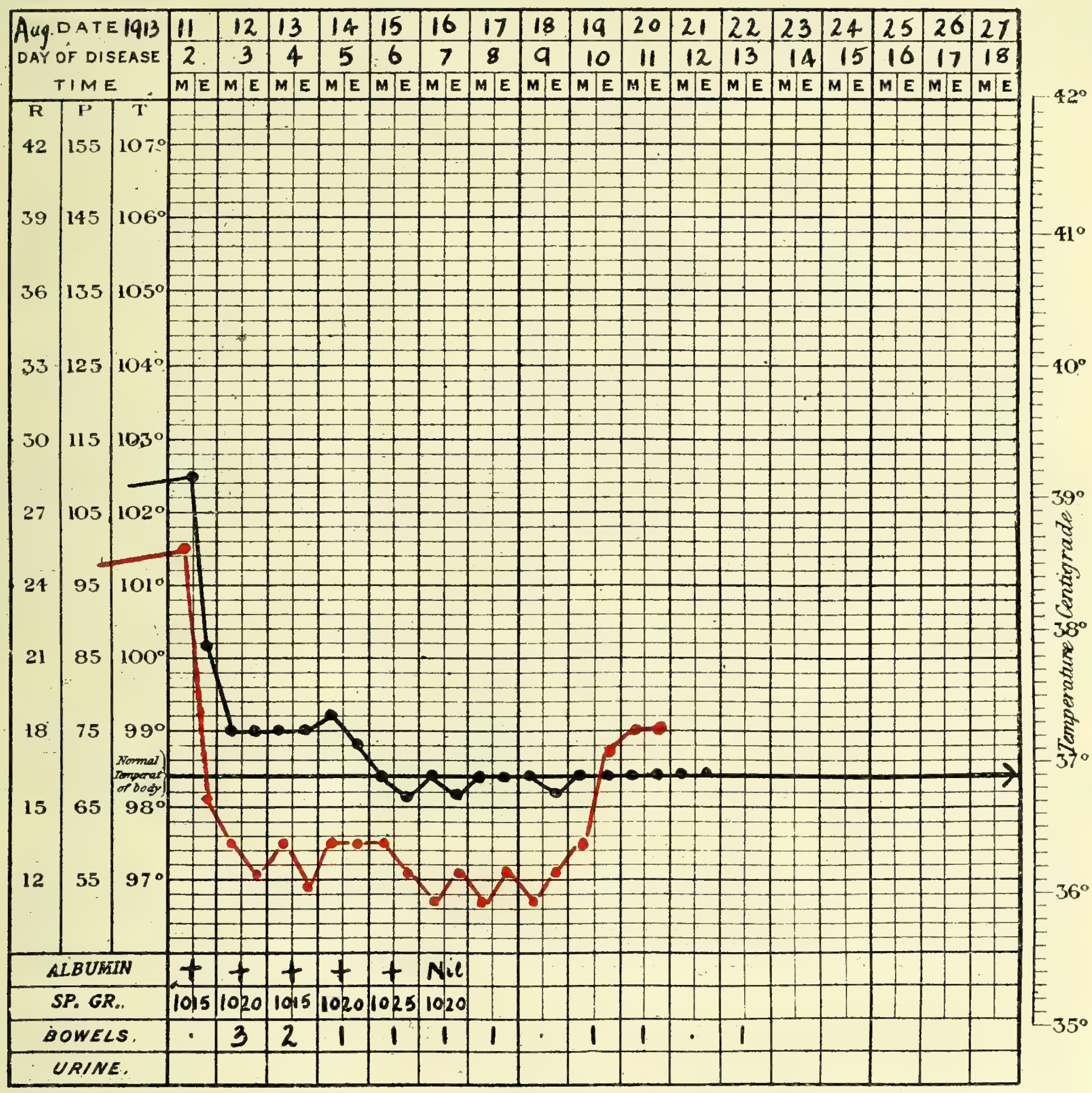


Chart 18

Blood examination.—No malaria parasites present. *Paraplasma flavigenum* present. Leucopenia present. Pigmented leucocytes present. Differential count: Polymorphonuclear, 75 per cent.; mononuclear, 7·5 per cent.; lymphocytes, 17·5 per cent.

Temperature at 8 p.m. was 100·2°, pulse rate 66.

12*th August.*—Patient had a bad night, did not sleep. Headache and loin pains severe. No vomiting, but nausea present with epigastric discomfort.

Bowels opened three times. Urine passed in small quantities. On examination it was acid. Sp. gr. 1020. Albumen present. Temperature at 8 a.m. was 99°, pulse 60, and at 8 p.m. 99, with pulse rate 56.

13th August. Patient had a better night. Headache and pains not so severe. Nausea still present. Urine passed in greater quantity and still contains albumen. Sclerae are tinged with yellow. Temperature at 8 a.m. was 99°, pulse 60, and at 8 p.m. 99°, pulse rate 54.

14th August.—Patient is doing well and is much improved. Headache and pains quite gone. Bowels regular. Urine increased in amount but still contains albumen. Sclerae still yellow.

Patient continued to do well, urine returned to the normal amount and albumen disappeared on the 16th and bile appeared. Jaundice deepened and gradually disappeared on the 18th and the patient made an uneventful recovery, and was discharged on the 28th.

Case No. 19. L. 52

Sex: Male.
Age: 20 years.
Nationality: Negro, Krooboy.
Occupation: Servant.
Date of admission: 13th August, 1913.
Date of discharge: 26th August, 1913.
Diagnosis: Yellow fever.

History.—Patient, a servant at an hotel and residing near the house in which Case No. 18 had occurred, was under surveillance, and the Senior Sanitary Officer finding that he had a temperature this morning sent him into hospital. He states that his illness began yesterday, the 12th, with a sensation of chilliness followed by pyrexia.

On admission.—Patient looked distressed. Temperature was 100·8°, pulse 80. Complains of frontal headache and pains in the loins and extremities. Eyes are watery and the conjunctivae injected and red.

Alimentary system.—Appetite lost. Bowels constipated. No vomiting. Tongue is pointed, furred, with red tip and edges. Gums are red and swollen. Liver normal. Spleen is normal, no tenderness. No epigastric tenderness.

Circulatory system.—Heart sounds normal. Pulse, low tension, 80 per minute.

Respiratory system.—Lungs normal. Respirations hurried, 26 per minute.

Nervous system.—Frontal headache and pains in the loins and extremities.

Urinary system.—Urine high coloured. Acid reaction. Sp. gr. 1014. Albumen present.

Blood examination.—No malaria parasites present. *Paraplasma flavigenum* present. Pigmented leucocytes present. Leucopenia present. Differential count: Polymorphonuclear, 68·5 per cent.; lymphocytes, 18·5 per cent.; mononuclear, 8·5 per cent.; eosinophil, 0·3 per cent; transitionals, 4·2 per cent.

Temperature at 8 p.m. was 100·6°, pulse rate 66.

14th August.—Patient did not have a good night. Headache severe. Pains in the loins and extremities also severe. Conjunctivae very injected and red. Urine diminished in quantity, acid reaction, and albumen present. No vomiting, but nausea is present. Temperature at 8 a.m. was 99°, pulse 72 and at 8 p.m. 99·8°, pulse rate 80.

15th August.—Temperature at 8 a.m. was 99°, pulse rate 66.

Patient is much better. Headache and pains not so severe. Bowels opened.

Urine still diminished and contains albumen. Temperature at 8 p.m. 99·6° and pulse rate 60. Sclerae are tinged with yellow.

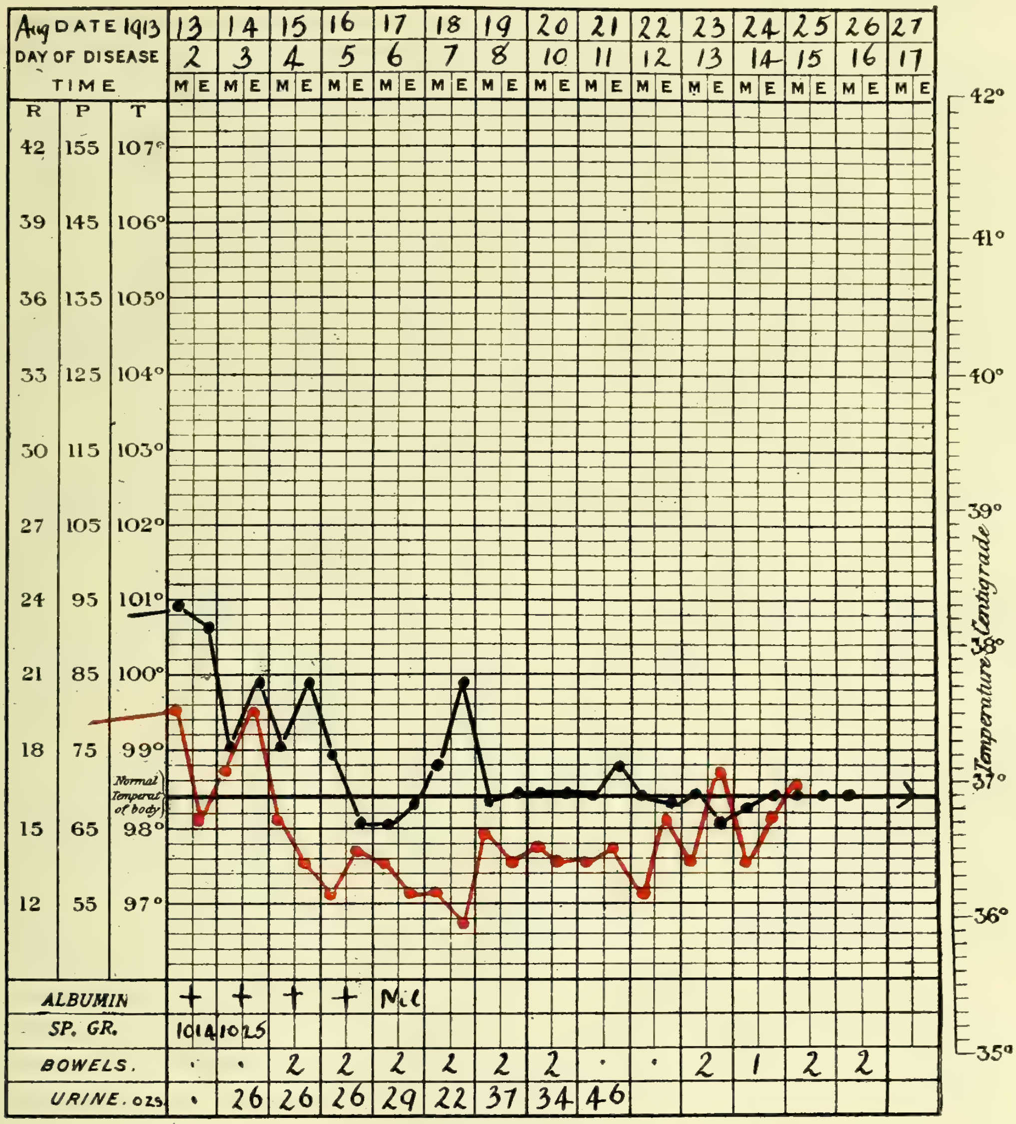


Chart 19

16*th August.*—Patient is doing well. Is much improved. No headache or pains. Appetite is returning. Urine is increased and the albumen has disappeared and bile is now present. Temperature at 8 a.m. was 98·8°, pulse 56, and at 8 p.m. 98° with pulse of 62.

Patient continued to do well. Jaundice deepened and then gradually disappeared on the 19th, and the patient was discharged cured on the 26th August.

Case No. 20. L. 53

Sex: Male.
Age: 38 years.
Nationality: Negro, Krooboy.
Occupation: A quartermaster. Government yacht ‘Ivy.’
Date of admission: 16th August, 1913.
Date of discharge: 27th August, 1913.
Diagnosis: Yellow fever.

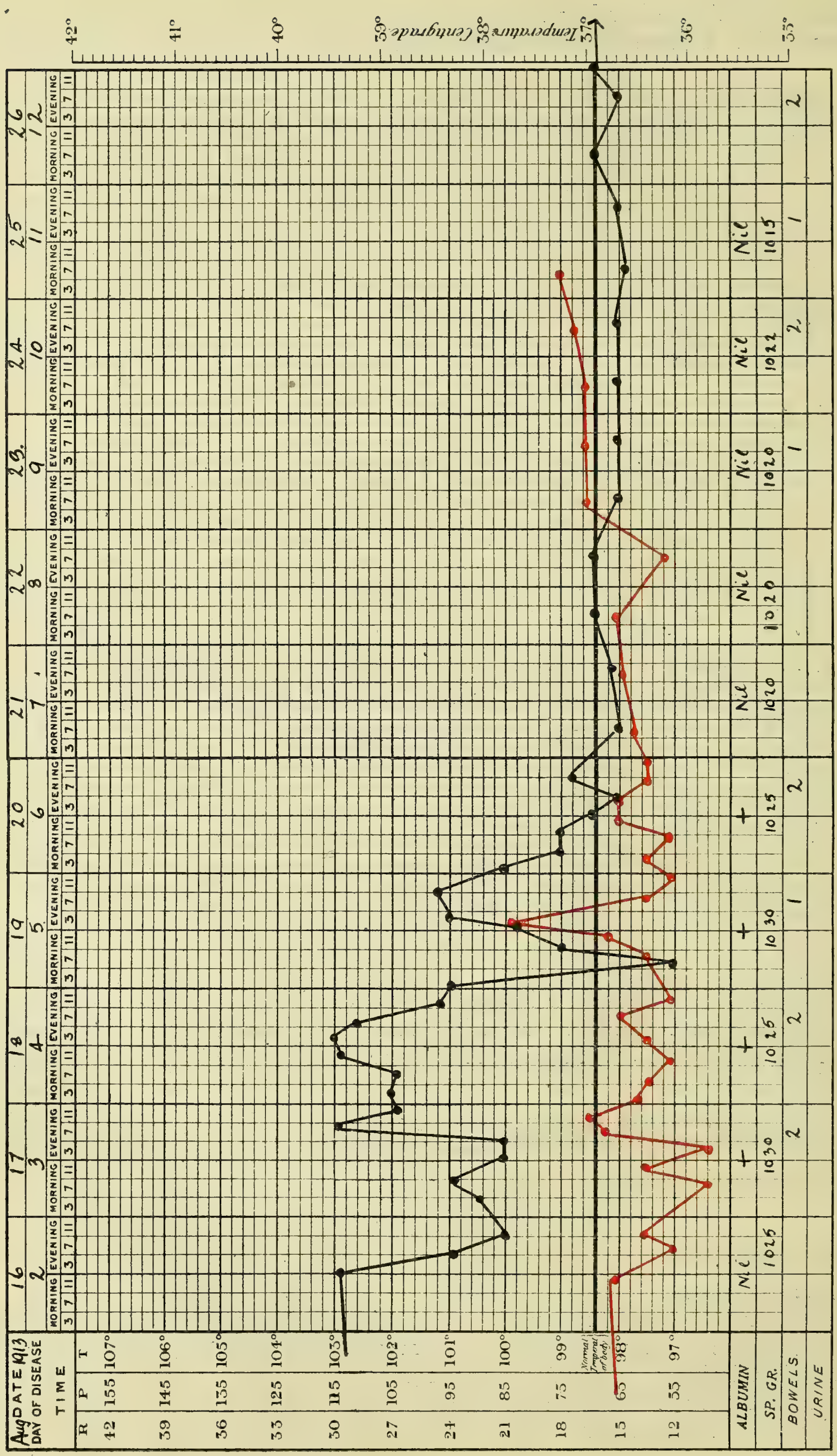

Aug 1913 DATE
DAY OF DISEASE
TIME
MORNING EVENING
R P T
Temperature Centigrade
ALBUMIN
SP. GR.
BOWELS
URINE
Normal Temperature of body

Chart 20

History.—Patient, who had been living ashore for the past 14 days while the Government yacht 'Ivy' was at Lagos, states that he has been feeling seedy for the past two days. On the night of the 15th he felt very ill with severe frontal headache and pyrexia. He had a very bad night and reported sick next morning. He was sent to the Lagos hospital.

On admission.—Patient was admitted at 2 p.m. Temperature 102·8°, pulse 66. He looked very ill and in great distress. Complained of severe frontal and occipital headache, aching pains in the loins and extremities. Respirations were hurried.

Alimentary system.—Appetite lost. Bowels constipated. Tongue, furred dorsum with red tip and edges. Liver normal. Spleen appears normal, no tenderness. He has had no vomiting. Nausea is present. Epigastrium is tender and uncomfortable.

Circulatory system.—Heart sounds are normal. Pulse rate 66 per minute.

Respiratory system.—Lungs normal. Respirations hurried.

Nervous system.—Severe frontal headache. Aching pains in the loins and limbs.

Urinary system.—Urine high coloured. On examination : Acid reaction. Sp. gr. 1025. No albumen.

Blood examination.—Malaria parasites present. Pigmented leucocytes present. *Paraplasma flavigenum* present. Differential count : Polymorphonuclear, 68·5 per cent. ; lymphocytes, 23·5 per cent. ; mononuclear, 7·8 per cent. ; eosinophil, 0·2 per cent.

17*th August.*—Patient had a bad night, did not sleep. Headache severe, also pains in the back. Nausea present but no vomiting. Urine passed in the night, very high coloured. Sp. gr. 1030. Albumen present. Conjunctivae very injected. Temperature at 8 a.m. was 100°, pulse 50. At 8 p.m. it was 101·8, pulse rate 68.

18*th August.*—Patient had a poor night, did not sleep well. Headache severe. Eyes injected. Tongue very red and pointed. Urine is diminished and high coloured and contains albumen. Bowels opened. Temperature at 8 a.m. was 102·8°, pulse rate 60, and at 8 p.m. 101·2°, pulse 65.

19*th August.*—Temperature at 8 a.m. was 99°, pulse 84.

Patient had a better night. Headache gone. Conjunctivae not so injected. Tongue moist. Bowels opened. Urine increased in amount but still contains albumen. Temperature at 8 p.m. 101·2°, pulse rate 60.

20*th August.*—Patient had a good night and feels very much better. No headache or loin pains. Sclerae are now yellow. Urine is increased and still contains albumen, but the percentage is diminished.

Temperature at 8 a.m. was 99°, pulse rate 65. At 8 p.m. 98·6°, with pulse of 60.

21*st August.*—Patient doing well. Appetite has returned. Sclerae are very yellow. Bowels regular. Urine is now normal in quantity and on examination is acid in reaction. Sp. gr. 1018. No albumen present. Bile present. Temperature is normal with a pulse rate of 56 at 8 a.m. and 65 at 8 p.m.

Patient continued to do well. Jaundice persisted until the 23rd of August and then cleared up. Patient was discharged cured on the 27th August.

CASE No. 21. L. 55

Sex : Male.
Age : 29 years.
Nationality : Negro, Yoruba.
Occupation : Trader.

Date of admission : 22nd August, 1913.
Date of discharge : 7th September, 1913.
Diagnosis : Yellow fever.

History.—Patient was sent to the hospital by the Medical Officer at Ebute Metta from off the evening passenger train from Ibadan, as he was found to have a temperature of 103°. He was a passenger from Ogbomosho, via Oyo and Ibadan. He had not been in Lagos for the past four weeks.

On admission.—Patient's temperature was 101·6°, pulse rate 66. Complained of frontal headache and pains in the extremities. Conjunctivae were injected and red.

Alimentary system.—Gums swollen and red. Appetite lost. Bowels constipated. No vomiting. Nausea present. Tongue was pointed and red. Liver normal. Spleen also normal, no tenderness.

Circulatory system.—Heart sounds were normal. Pulse 66 per minute. Low tension.

Respiratory system.—Lungs were normal.

Nervous system.—Frontal headache. Pains in the back and extremities. Reflexes were normal.

Urinary system.—Urine was high coloured and scanty. Examination : Acid reaction. Sp. gr. 1030. Albumen present.

Blood examination.—A few malaria parasites present. Leucopenia present. Pigmented leucocytes present. Differential count : Polymorphonuclear, 78 per cent. ; mononuclear, 6·8 per cent. ; lymphocytes, 15·2 per cent.

Temperature at 8 p.m. that night was 101·2°, pulse rate 56.

23rd August.—Patient had a fair night. Headache still present. Bowels were opened. Urine passed freely and albumen found to be present. Temperature at 8 a.m. was 100°, pulse rate 52, and at 8 p.m. 98·4° with a pulse of 52.

24th August.—Patient had a good night. Feels very much improved. Headache still present but slight. Lumbar pains quite gone. Bowels opened. Urine increased in amount and on examination is acid in reaction. Sp. gr. 1030. Albumen still present. Temperature is normal with a pulse rate of 50.

Patient continued to do well. Appetite improved. Headache disappeared. Sclerae became yellow on the 26th, and albumen disappeared from the urine on the same date. Jaundice continued until the 2nd of September and then disappeared. Patient was discharged cured on the 7th September

Case No. 22. L. 56

Sex : Male.
Age : 27 years.
Nationality : Negro, Yoruba.
Occupation : Police-constable.
Date of admission : 27th August, 1913.
Date of discharge : 9th September, 1913.
Diagnosis : Yellow fever.

History.—Patient states that he became ill yesterday at 6 p.m. with rigors accompanied by severe frontal headache and pains in the occipital region. He also had fever and at 8 p.m. had an attack of diarrhoea. Nausea was present but he had no vomiting. He got worse during the night and reported sick next morning and was sent to hospital.

On admission.—Temperature 102·6°, pulse rate 86. Complains of severe frontal headache and occipital pains. He also has severe pains in the loins and extremities. Eyes are watery and the conjunctivae are red and injected.

Alimentary system.—Appetite lost. No vomiting, but nausea present. Diarrhoea at commencement of illness. Tongue furred. Liver and spleen both normal. No epigastric tenderness. Pharynx is red and congested.

Circulatory system.—Heart sounds are normal. Pulse 86 per minute.

Respiratory system.—Lungs normal. Respirations 28 per minute.

Nervous system.—Severe frontal and occipital headache. Aching pains in the loins and extremities. Reflexes were normal.

Urinary system.—Urine was very high coloured. On examination: Acid reaction. Sp. gr. 1020. No albumen present.

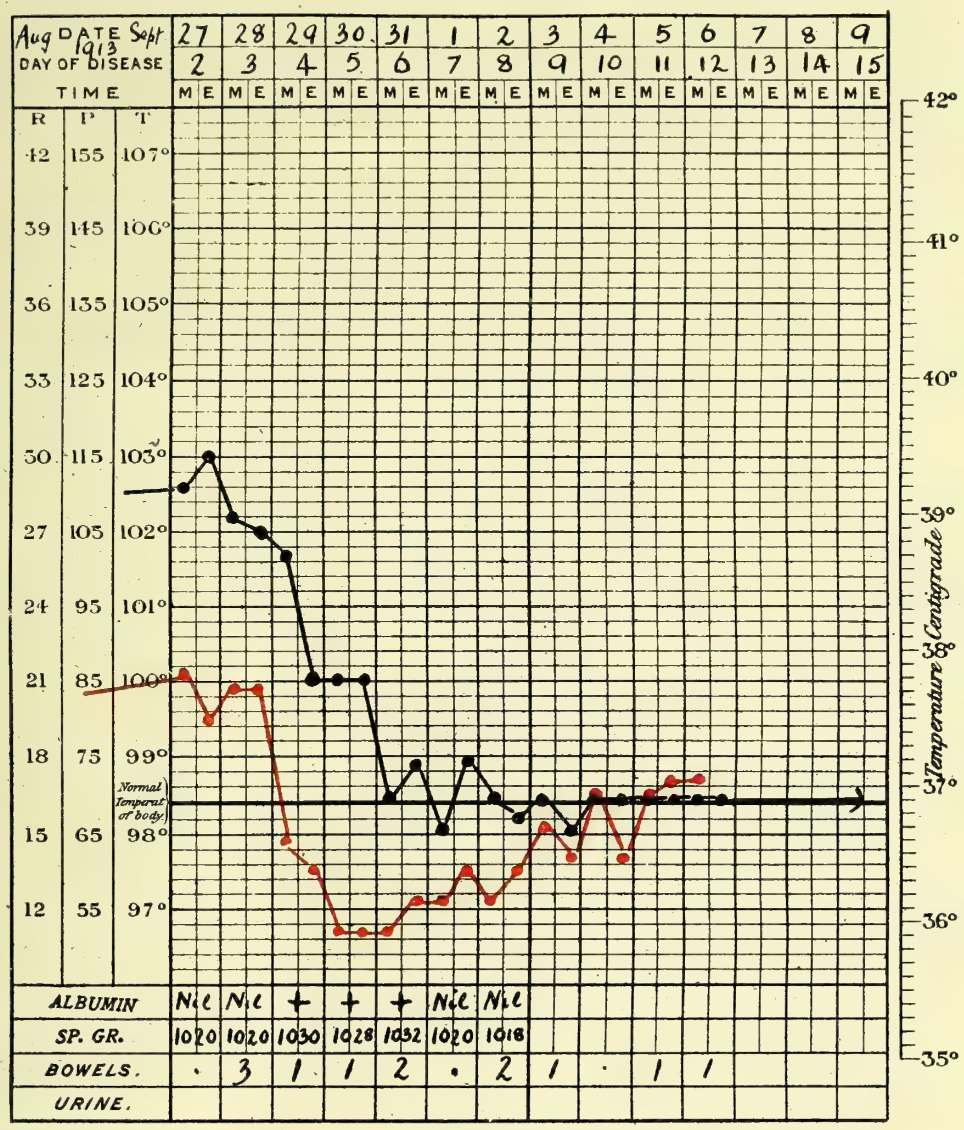


Chart 21

Blood examination.—No malaria parasites present. Leucopenia present. Differential count: Polymorphonuclear, 78 per cent.; lymphocytes, 16 per cent.; mononuclear, 5·5 per cent.; eosinophil, 0·5 per cent.

Temperature rose during the afternoon and at 8 p.m. was 103°, with a pulse rate of 80.

28*th August.*—Temperature at 8 a.m. was 102·2°, pulse rate 84.

Patient had a bad night and was very restless. Headache very severe. No vomiting but nausea troublesome. Urine was passed during the night and was very high coloured but contained no albumen. At 8 p.m. temperature was 102°, pulse rate 84.

29th August.—Patient had another bad night and did not sleep. Complained of severe headache and loin pains. Conjunctivae very injected. Eyes shining. Vomited several times during the night. Vomited matter consisted of greenish fluid with chocolate-coloured débris. Urine was scanty and on examination was acid in reaction. Sp. gr. 1030. Albumen present. Temperature at 8 a.m. was 101·6°, pulse 64, and at 8 p.m. 100°, with a pulse of 60.

30th August.—Patient had a better night. Pains are easier and the headache not so severe. Bowels were opened. No further vomiting but nausea still present. Urine is diminished and contains albumen.

31st August.—Patient had a much better night. He is feeling very much improved. No vomiting and the nausea is disappearing. Bowels have been opened. Urine increased in amount but still contains some albumen. Sclerae are tinged with yellow. Temperature at 8 a.m. was 98·4°, pulse 52, and at 8 p.m. 98·6°, pulse rate 56.

1st September.—Patient had a good night. Slept well. No headache or pains. Appetite has improved. Sclerae are now quite yellow. Urine has become normal in quantity and the albumen has disappeared, bile taking its place. Temperature at 8 a.m. was 98°, pulse 56, and at 8 p.m. 98·6°, pulse rate 60.

Patient continued to do well, jaundice disappeared gradually and the patient was discharged cured on the 9th September.

Case No. 23. L. 63

Sex : Male.
Age : 22 years.
Nationality : Negro, Sobo tribe.
Occupation : Labourer.
Date of admission : 29th August, 1913.
Date of discharge : 22nd September, 1913.
Diagnosis : Yellow fever.

History.—Patient states that he became ill last night. He had severe frontal headache and fever, and had a bad night. He attended the dispensary, and as his temperature was 105°, he was sent into the hospital.

On admission.—Patient looked very ill, skin very dry and hot. Temperature was 100·6°, pulse 100. Complained of severe frontal headache and pains in the back and limbs. Conjunctivae were injected.

Alimentary system.—Appetite lost. Bowels constipated. Tongue furred, with red tip and edges. Liver normal. Spleen normal and tender on palpation. No vomiting. Epigastrium tender on pressure.

Circulatory system.—Heart sounds were normal. Pulse 100 per minute.

Respiratory system.—Lungs normal.

Nervous system.—Severe frontal headache. Aching pains in the loins and limbs. Reflexes normal.

Urinary system.—Urine passed on admission. Very high coloured. Examination : Acid reaction. Sp. gr. 1020. No albumen present.

Blood examination.—Malaria parasites present. Pigmented leucocytes present. Differential count : Polymorphonuclear, 75 per cent. ; mononuclear, 8·5 per cent. ; lymphocytes, 16 per cent. ; eosinophil, 0·5 per cent.

Patient was put on quinine.

Temperature at 8 p.m. was 100°, pulse rate 68.

30th August.—Temperature at 8 a.m. was 99·8°, pulse 80.

Patient had a good night. Bowels moved freely. Passed 20 ounces of urine through the night. Examination: Acid reaction. Sp. gr. 1025. No albumen.

Temperature at 8 p.m. was 101·4°, pulse rate 72.

31*st August.*—Temperature at 8 a.m. was 104°, pulse rate 70.

Patient had a very bad night. Headache and pains in the loins and extremities very severe. Conjunctivae very injected. Nausea present. Temperature at 8 p.m. 103·4°, pulse rate 80. Urine was scanty and high coloured, acid in reaction and albumen present.

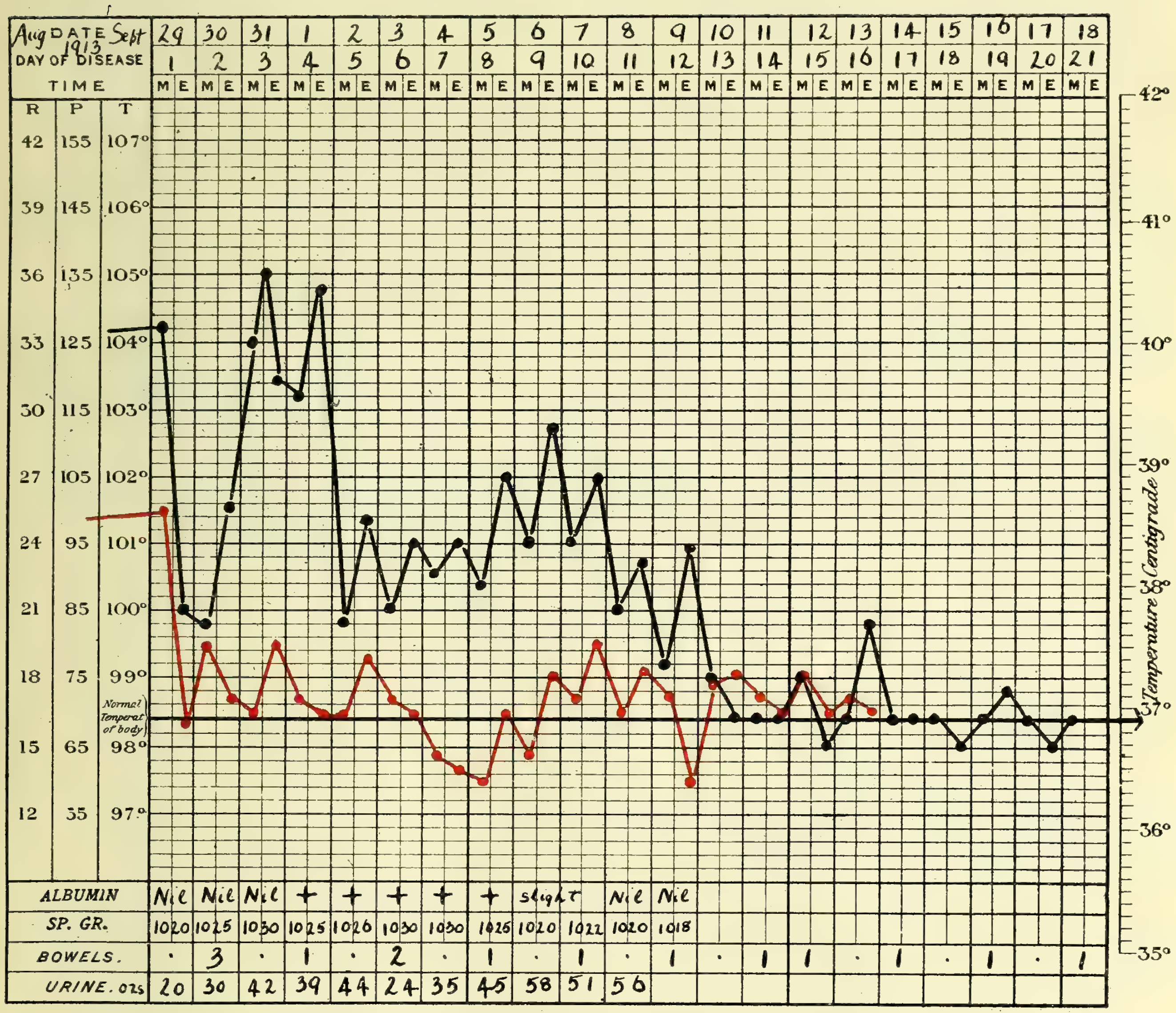


Chart 22

1*st September.*—Temperature at 8 a.m. was 103·2°, pulse 72.

Patient had another bad night. Very restless. Looks very ill and distressed. Respirations hurried. Conjunctivae very injected. Headache very severe. Aching pains in the loins and extremities.

Urine is scanty and high coloured. Examination: Acid reaction. Sp. gr. 1021. Albumen present. Blood examination: No malaria parasites present. *Paraplasma flavigenum* present. Leucopenia present. Differential count: Polymorphonuclear, 68·7 per cent.; mononuclear, 13·4 per cent.; lymphocytes, 17·4 per cent.; eosinophil, 0·5 per cent.

Temperature at 8 p.m. was 104·8°, pulse rate 70.

2nd September.—Patient had a restless night, no sleep. Headache severe. Tongue is pointed and red. Conjunctivae still injected. Bowels opened. Urine diminished and contains albumen. Temperature at 8 a.m. was 99·6°, pulse rate 76, and at 8 p.m. 101·6°, pulse 78.

3rd September.—Patient had a better night. Headache and pains in the back still present but not so severe. Urine shows an increased amount but still contains albumen. Temperature at 8 a.m. 100°, pulse 72, and at 8 p.m. 101°, pulse 70.

4th September.—Patient is much better and had a fair night. Bowels opened. Urine still not normal in quantity and contains albumen. Headache pains are decreasing in severity. Temperature at 8 a.m. 100·6°, pulse 64, and at 8 p.m. 102°, pulse rate 62.

5th September.—Patient is very much better and had a good night. Headache and loin pains still present, but slight. Urine still contains albumen and is diminished in quantity. Temperature at 8 a.m. 100·4°, pulse 60, and at 8 p.m. 102°, pulse 70.

6th September.—Patient had a good night. Feels very well. No headache or pains. Urine increased in amount and albumen present, but lessened in amount. Sclerae are tinged with yellow. Temperature at 8 a.m. 101°, pulse 64, and at 8 p.m. 102·6°, pulse rate 75.

Patient continued to progress favourably. Temperature gradually returned to normal, while the pulse rate still remained low. Albumen disappeared from the urine on the 8th September, and bile made its appearance. The jaundice deepened and persisted until the 16th, and then gradually disappeared. Appetite returned and urine regained its normal quantity. Patient was discharged cured on the 22nd September.

Case No. 24. L. 64

Sex: Male.
Age: 27 years.
Nationality: Negro, Yoruba.
Occupation: Clerk.
Date of admission: 24th September, 1913.
Date of discharge: 8th October, 1913.
Diagnosis: Yellow fever.

History.—Patient states that he felt ill four days ago with a sensation of chilliness and headache. He continued at his work for a couple of days, but felt worse each day. Headache became severe and the pyrexia more pronounced. On the 23rd he felt very ill and took to his bed, and on the 24th he was sent into hospital.

On admission.—Patient complained of severe frontal headache, and aching pains in the loins and extremities. Respirations were hurried, and he seemed very distressed. Conjunctivae were injected and red. Eyes shining. Temperature 102·4°, pulse rate 96.

Alimentary system.—Appetite lost. Bowels constipated and nausea present. Had no vomiting. Liver and spleen both normal, no tenderness. Epigastric pains and discomfort present. Tongue pointed and red. Gums were swollen and red.

Circulatory system.—Heart sounds were normal. Pulse 96 per minute.

Respiratory system.—Lungs normal. Respirations hurried.

Nervous system.—Severe frontal headache. Aching pains in the loins and extremities.

Urinary system.—Patient states that urine has been scanty for the past three

days. On examination: Very high coloured. Acid reaction. Sp. gr. 1030 Albumen present.

Blood examination.—Ring forms of malaria parasite present. Leucopenia present. *Paraplasma flavigenum* present. Differential count: Polymorphonuclear, 65 per cent.; mononuclear, 8 per cent.; lymphocytes, 24 per cent.; eosinophil, 3 per cent.

Temperature rose towards evening and at 8 p.m. was 103°, pulse 80.

25th September.—Patient had a bad night, very restless. Headache and loin pain very severe. No vomiting. Passed 16 ozs. of urine, very high coloured and containing albumen. Temperature at 8 a.m. 101°, pulse 64, and at 8 p.m. 99·6°, pulse rate 52.

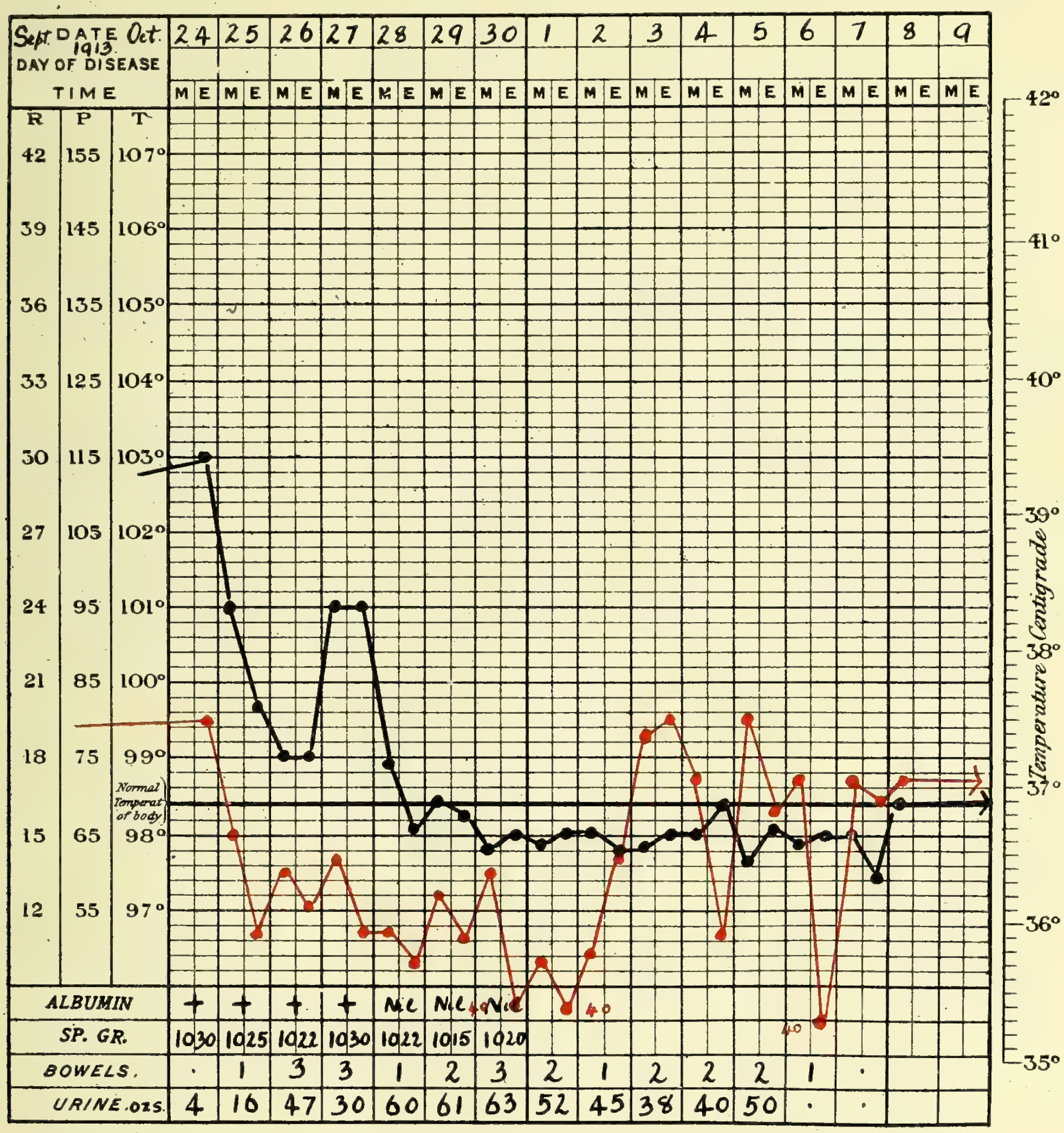


Chart 23.

26th September.—Patient had a better night and slept much more. Still complains of frontal headache and pains in the loins and extremities, but lessened in severity. Bowels opened. Urine increased in amount and albumen still present. Temperature at 8 a.m. 99°, pulse 60, and at 8 p.m. 99°, pulse rate 54.

27th September.—Patient is very much improved, had a good night. Bowels opened. Urine passed in larger quantity. Albumen still present but is lessened in

amount. Sclerae are yellow. Headache and backache nearly gone. Temperature at 8 a.m. 101°, pulse 62, and at 8 p.m. 101°, pulse rate 52.

28th September.—Patient had a good night. Appetite is returning. Bowels regular. Urine has returned to the normal quantity. On examination: Acid reaction. Sp. gr. 1022. No albumen present. Jaundice is now well marked. Temperature at 8 a.m. was 98·8°, pulse 52, and at 8 p.m. 98°, with a pulse rate of 48.

Patient continued to do well. Appetite improved. Urine is now normal. Bowels regular. Jaundice persisted until the 5th October, and then disappeared. Patient was discharged cured on the 8th October.

Case No. 25. L. 69

Sex: Male.
Age: 21 years.
Nationality: Negro, Yoruba.
Occupation: Barber.
Date of admission: 3rd October, 1913.
Date of discharge: 14th October, 1913.
Diagnosis: Yellow fever.

History.—Patient states that on the 30th September he first felt ill, with a severe headache and chilliness. At night, he was much worse and had fever, did not sleep and was very restless. Next day, he was much worse, severe frontal headache and aching pains in the loins and extremities being present. He noticed that his eyes were very red and that his urine was scanty. Yesterday, the 2nd October, he felt very much worse and had a bad night, the headache and pains having increased in severity; epigastric pain and nausea, followed by vomiting, also present. Bowels were constipated, vomiting was very troublesome, and the urine diminished in quantity. On the 3rd, he was seen by a Medical Officer and sent into hospital. His temperature, taken in his house, was 102·6°, pulse rate 60.

On admission.—Temperature 101·2°, pulse 80. Skin dry. Conjunctivae injected and red. Eyes shining and watery. Complains of severe frontal headache and pains in the loins and extremities.

Alimentary system.—Tongue dry and pointed, furred dorsum with red tip and edges. Liver and spleen were normal, no tenderness. Epigastric pain and discomfort present. Nausea present. Gums were red and swollen. Bowels constipated. Vomiting had stopped.

Circulatory system.—Heart sounds were normal. Pulse, low tension, 80 per minute.

Respiratory system.—Lungs were normal. Respirations hurried.

Nervous system.—Severe frontal headache. Aching pains in the loins and the extremities. Reflexes were normal.

Urinary system.—Urine scanty and high coloured. On examination: Acid reaction. Sp. gr. 1025. Albumen present. Tube casts present.

Blood examination.—No malaria parasites present. Leucopenia present. *Paraplasma flavigenum* present. Differential count: Polymorphonuclear, 48·6 per cent.; mononuclear, 13·4 per cent.; lymphocytes, 23·8 per cent.; eosinophil, 3·3 per cent.; transitionals, 8·7 per cent.; mast cells, 2·2 per cent. Haemoglobin, 80 per cent.

4th October.—Patient passed a fair night and feels better this morning. Headache and loin pains are less. Epigastric pain and discomfort still present. No vomiting, but nausea present. Bowels opened. Urine contains albumen. Temperature at 8 a.m. 97·8°, pulse 56, and at 8 p.m. 97·2°, pulse 50.

5th October.—Patient very much improved. Had a good night. Headache and pains quite gone. Urine increased in amount and albumen present still, but the percentage is lower. Conjunctival injection passing off and sclerae tinged with yellow. Temperature has fallen, and the pulse rate is 50 per minute.

6th October.—Patient doing well. Bowels are regular and appetite improved. The epigastralgia has quite gone. Urine increased in quantity and only contains a trace of albumen. Pulse slow. Sclerae yellow. Patient continued to do well. Albumen disappeared from the urine on the 7th and the jaundice was more apparent. Convalescence was quick, the jaundice passed off gradually and disappeared on the 13th. The patient was discharged cured on the 14th October.

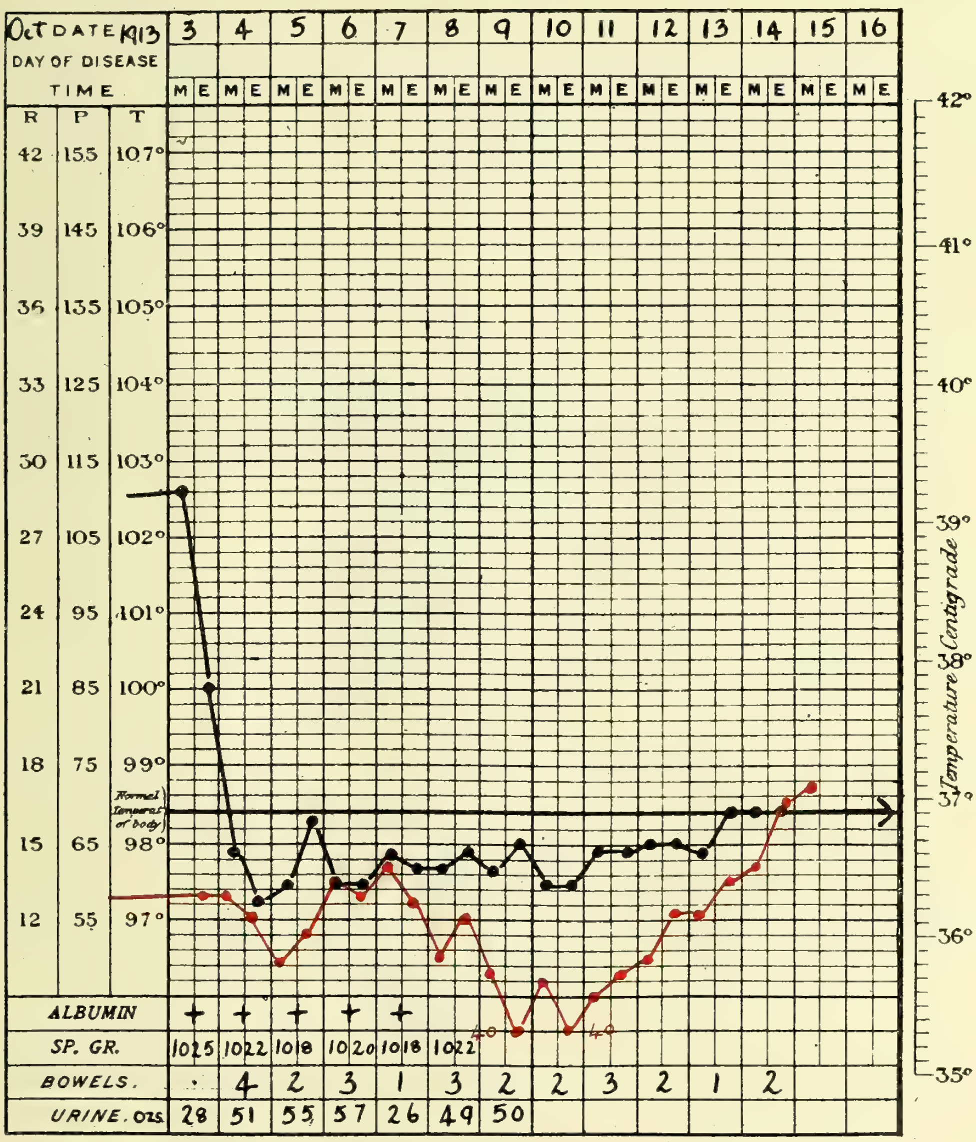


Chart 24.

CASE No. 26. L. 73

Sex : Male.
Age : 36 years.
Nationality : Negro, Yoruba.
Occupation : Police constable.
Date of admission : 13th October, 1913.
Date of discharge : 6th November, 1913.
Diagnosis : Yellow fever.

History.—Patient states that he got ill on the afternoon of the 11th with rigors, followed by fever and severe headache and aching pains in the loins and extremities. On the 12th, he felt much worse, nausea was present with epigastric pain and discomfort. Bowels were constipated. He reported sick and was sent to the hospital.

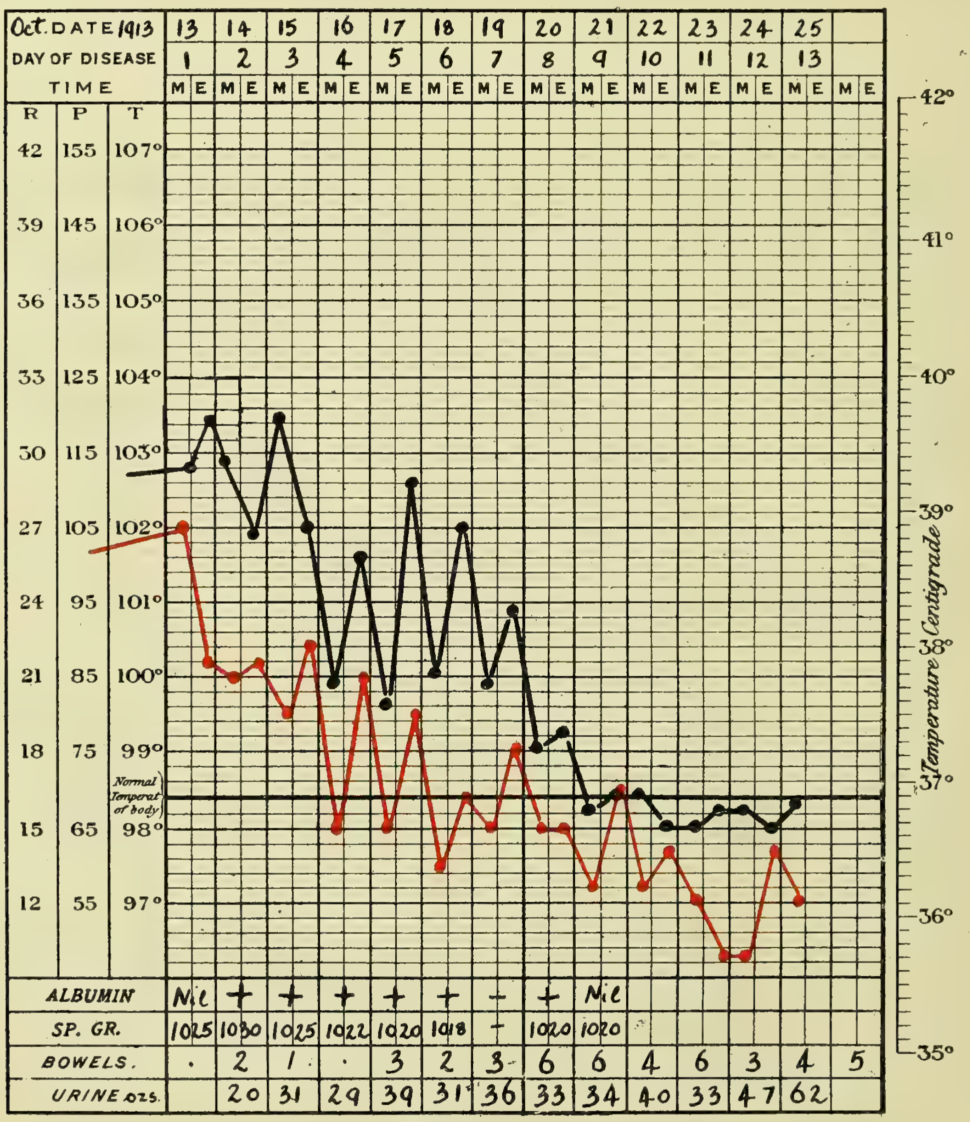


Chart 25

On admission.—Temperature was 102·8°, pulse 115 per minute. Skin was dry, conjunctivae injected and red. Complained of severe frontal headache and aching pains in the back and extremities.

Alimentary system.—Gums were red and swollen. Tongue pointed and furred, with clean tip and edges. Nausea present with epigastric pain and discomfort. Liver normal. Spleen enlarged, no tenderness. Bowels had been opened.

Circulatory system.—Heart normal. Pulse 115 per minute.

Respiratory system.—Lungs were normal.

Nervous system.—Severe frontal headache. Aching pain in the loins and extremities. Reflexes normal.

Urinary system.—Urine passed on admission. High coloured. On examination: Acid reaction. Sp. gr. 1025, no albumen present.

Blood examination.—Few malaria parasites present. *Paraplasma flavigenum* present. Leucopenia present. Differential count: Polymorphonuclear, 66·4 per cent.; mononuclear, 11·6 per cent.; lymphocytes, 18·8 per cent.; eosinophil, 3·2 per cent.

14th October.—Patient had a bad night, headache and loin pains severe, nausea present, but no vomiting. Temperature at 8 a.m. was 102°, pulse 84. In the afternoon temperature rose to 105°, pulse 80, and at 8 p.m. fell to 101·8°, with pulse 86. Urine was diminished and on examination was acid in reaction. Sp. gr. 1030, albumen present as well as tube casts.

15th October.—Patient had a restless night, headache and loin pain still very severe. No vomiting. Bowels opened. Urine diminished and still contains albumen. Temperature at 8 a.m. 103·4°, pulse 80, and at 8 p.m. it was 102°, pulse 84.

16th October.—Patient had a better night, headache and pains lessened in severity. Temperature at 8 a.m. was 99·8°, pulse 62. Urine increased but albumen still present, though lessened in amount. Sclerae are tinged with yellow. Temperature at 8 p.m. was 101·6°, pulse 86.

17th October.—Patient very much better. Appetite returning. No nausea or epigastric pain. Headache and loin pains nearly gone. Sclerae very yellow. Urine still contains a trace of albumen.

Patient continued to do well, temperature returned to normal. Albumen gradually diminished and disappeared from the urine on the 21st October, bile making its appearance, reaction being acid. Sclerae gradually lost their yellow colour and returned to the normal. Bowels were regular. The patient made an uneventful recovery, and was discharged cured on the 6th November.

Case No. 27. L. 90

Sex: Male.
Age: 29 years.
Nationality: Negro, Ibo tribe.
Occupation: Police-constable.
Date of admission: 17th October, 1913.
Date of discharge: 12th November, 1913.
Diagnosis: Yellow fever.

History.—This constable had come from Onitsha in charge of convicts and had stayed at Forcados for six days prior to coming to Lagos, where he arrived on the 15th October. Infection undoubtedly occurred at Forcados. He got ill on the 17th, with pyrexia accompanied by severe frontal headache and aching pains in the loins and extremities. Bowels were constipated. Nausea was present, but no vomiting. He was sent into hospital.

On admission.—Temperature was 101°, pulse 100. Complained of severe frontal headache and aching pains in the back and extremities. The conjunctivae were very injected and red.

Alimentary system.—Tongue was furred, with red tip and edges. Liver was normal. Spleen was normal, no tenderness. Bowels had been opened. Nausea present with epigastric pain and discomfort.

Circulatory system.—Heart sounds normal.

Respiratory system.—Lungs normal. Respirations hurried.

Nervous system.—Frontal headache. Aching pains in the loins and extremitie.

Urinary system.—Urine was passed on admission. Very high coloured. On examination: Acid reaction. Sp. gr. 1025. No albumen present.

Blood examination.—Malaria parasites present. *Paraplasma flavigenum* present. Leucopenia present. Differential count: Polymorphonuclear, 76 per cent.; mononuclear, 1·8 per cent.; lymphocytes, 15·2 per cent.; eosinophil, 4·2 per cent.; transitionals, 2·8 per cent.

At 8 p.m. temperature was 101°, pulse 80. Urine was passed, and on examination albumen was present; sp. gr. 1025, reaction acid.

18*th October.*—Patient had a bad night, headache and loin pain severe. No vomiting. Bowels were opened. Temperature at 8 a.m. 99°, with pulse 72. Urine on examination showed higher percentage of albumen and tube casts. Conjunctivae very injected and red. Temperature during the evening and at 8 p.m. was 101·4°, pulse rate 86.

19*th October.*—Patient slightly improved. Headache and loin pain still present. Nausea with epigastric discomfort passing off. Urine is increased in quantity and albumen present. Sp. gr. 1025, reaction acid. Temperature at 8 a.m. 99·6°, pulse rate 64, and at 8 p.m. 101°, with pulse 84. Patient continued to do well, slept better at nights. Sclerae became yellow on the 22nd, and the albumen cleared up on the same date. Temperature fell to normal and he made an uneventful recovery, and was discharged cured on the 12th November.

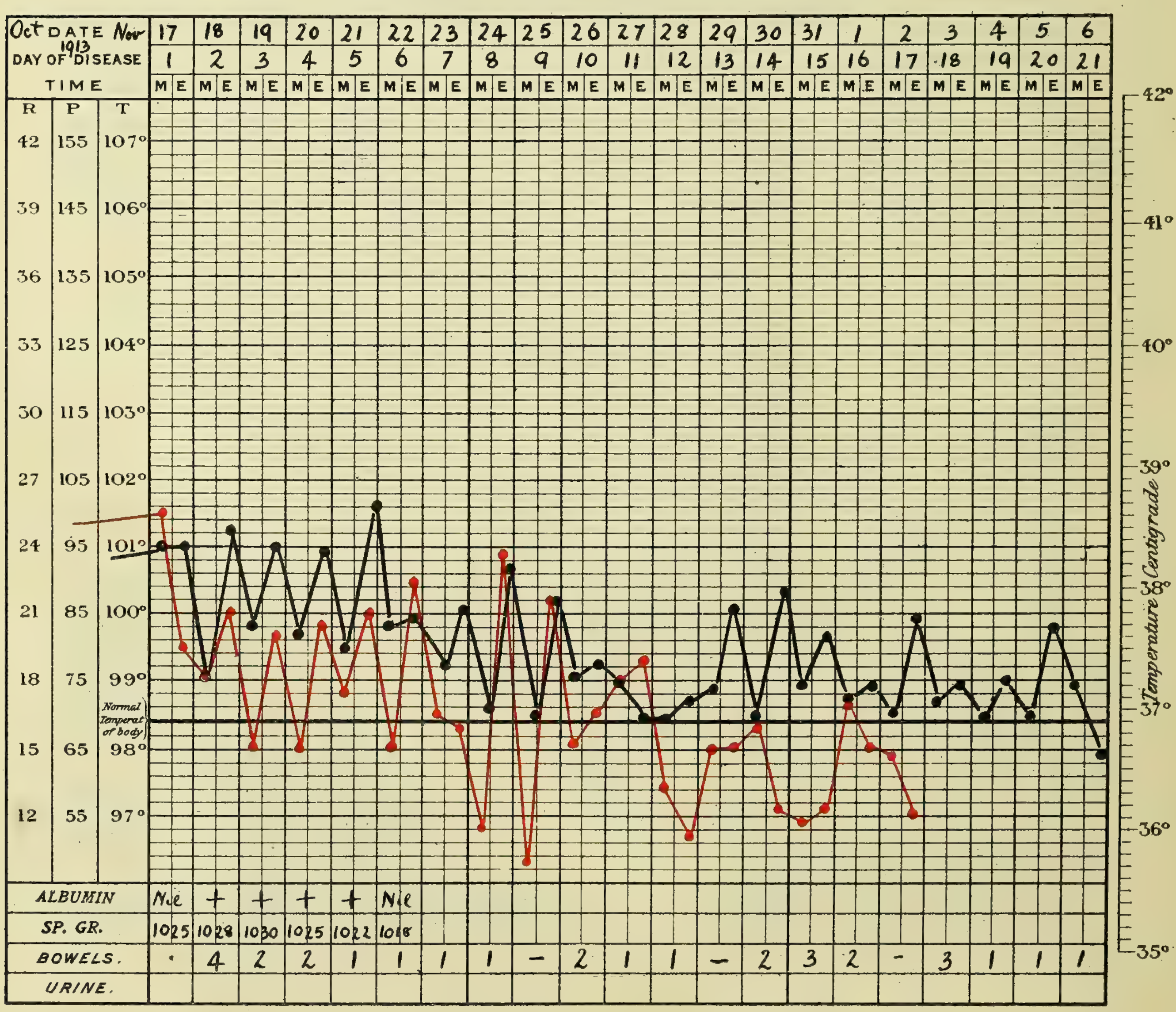


Chart 26

Case No. 28. L. 91

Sex: Male.
Age: 21 years.
Nationality: European, British.
Occupation: Trader.
Date of admission: 18th October, 1913.
Date of discharge: 3rd November, 1913.
Diagnosis: Yellow fever.

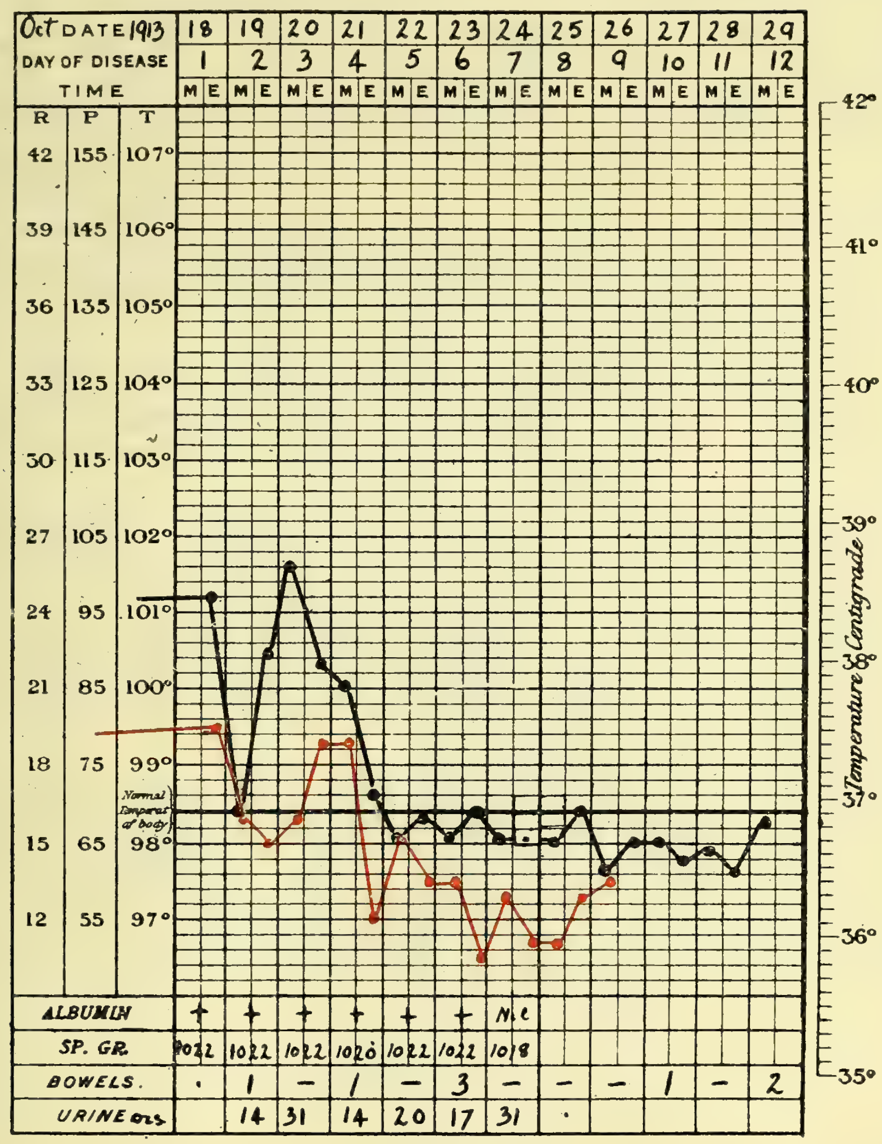


Chart 27

History.—Patient states that he first felt ill on the 16th, but continued at his work all that day. Next day, although still feeling seedy, he went to work again, but that night he had very severe frontal headache, and aching pains in the loins and extremities. His temperature was raised and he had vomiting. He was seen by a medical man next morning, the 18th, and as his condition grew worse towards evening, he was sent to the Lagos hospital and admitted at 10.30 p.m.

On admission.—Face was flushed. Conjunctivae injected. Complained of severe frontal headache, and aching pains in the back and limbs. Temperature was 101·4°, pulse rate 80.

Alimentary system.—Appetite lost. Bowels constipated. Tongue pointed, white dorsum with red tip and edges. Liver normal. Spleen also normal, no tenderness. Nausea with epigastric pain and discomfort present. No vomiting since the commencement of the illness.

Circulatory system.—Heart sounds normal. Pulse was slow and intermittent, 80 per minute.

Respiratory system.—Lungs normal.

Nervous system.—Frontal headache. Aching pains in the loins and extremities. Reflexes normal. Patient is hysterical and nervous.

Urinary system.—Patient said that his urine was diminished. He passed no urine from the time of his admission until 11 a.m. next day. Examination: Reaction acid. Sp. gr. 1022. Albumen present.

19*th October.*—Patient had a quiet night, temperature at 8 a.m. being 98·4°, pulse rate 70. Patient passed no urine through the night. The headache and loin pains were severe. Temperature rose at mid-day to 102·2°, pulse 68. Face very flushed, conjunctivae injected and red. Nausea and epigastric discomfort present. Temperature at 4 p.m. was 103·2°, with pulse of 68, conjunctivae very injected. Urine passed, and on examination was acid in reaction. Sp. gr. 1025, albumen and tube casts present.

Blood examination.—No malaria parasites present. *Paraplasma flavigenum* present. Leucopenia present. Differential count: Polymorphonuclear, 66 per cent.; lymphocytes, 22·5 per cent.; mononuclear, 11·3 per cent.; eosinophil, 0·2 per cent.

20*th October.*—Patient had a bad night, very restless. Headache and loin pain severe. Temperature 101°, pulse slow and intermittent. Urine is diminished in quantity, and albumen and tube casts present. Sclerae are tinged with yellow.

21*st October.*—Patient is much better. Headache and pains not so severe. Urine diminished and albuminous. Sp. gr. 1020. Pulse is slow and intermittent. Temperature dropped to 98·4° in the evening. Passed 20 ozs. of urine, albumen still present. Sclerae are much yellower.

22*nd October.*—Patient much improved, had a good night. Headache and loin pains gone. Urine increased in amount. Albumen still present but diminished. Appetite returning. Pulse has improved. Patient continued to do well, urine increased in quantity, and albumen disappeared on the 25th, bile appearing. Jaundice became marked and gradually disappeared on the 30th October, and the patient was discharged cured on the 3rd November.

Case No. 29. L. 102

Sex: Male.

Age: 21 years.

Nationality: European, German.

Occupation: Steward.

Date of death: 26th October.

Diagnosis after post-mortem examination: Yellow fever.

This case died on board the s.s. 'Elizabeth Brock,' at 7.10 a.m. on the 26th October. The body was brought ashore for an autopsy.

Previous history.—This was obtained from the captain of the vessel. The man complained of being ill on the morning of the 23rd October with headache and fever, temperature at noon that day being 103·2°, and at 8 p.m. 103·4°. Next day, the 24th, the temperature was 100·2° at 8 a.m., and 104° at 8 p.m. On the 25th, the temperature fell to 99·2° and then began steadily to rise, being 103·8°

at 8 p.m. that night, and next morning, the 26th, at 7 a.m. it was 106°, and the patient died at 7.10.

Autopsy performed at the Lagos hospital at 9 a.m.

Skin.—Sallow appearance. Deep cyanosis of the ears and genital organs. No rash present.

Rigor mortis.—Present.

Brain.—Normal.

Spinal cord.—Normal.

Membranes.—Normal.

Heart.—Weight 11½ ozs. Pale and flabby. Valves normal.

Large vessels.—Normal.

Lung, right.—Weight 18½ ozs. Very congested, particularly at base.

Lung, left.—Weight 17½ ozs. Congested.

Pleurae.—Normal. No adhesions. Contents 2 ozs. yellow fluid.

Larynx, trachea, bronchi: Mucous membrane congested.

Peritoneum.—Normal.

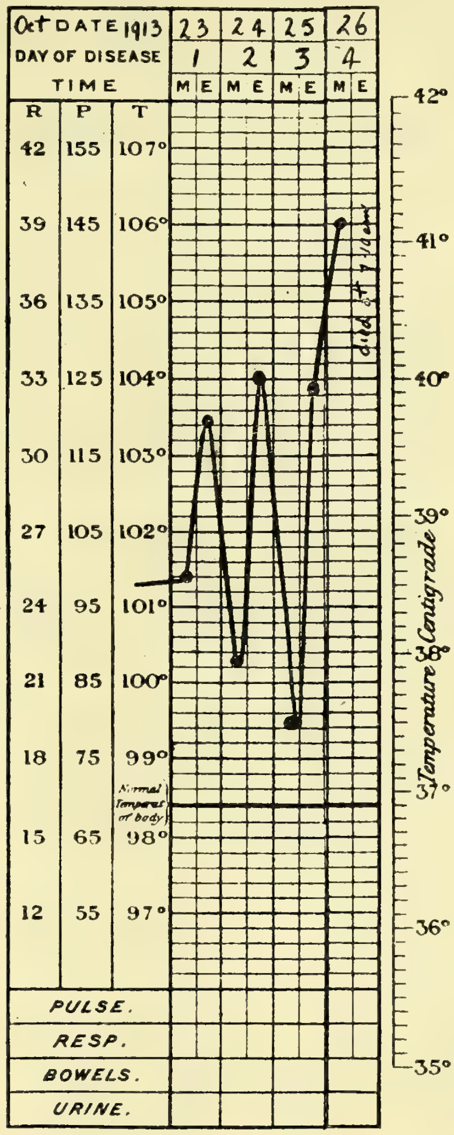


Chart 28

Stomach.—Mucous membrane congested. Rugae swollen. Extensive sub-mucous haemorrhages at the cardiac end, pylorus and posterior wall. Vessels engorged. Stomach empty, brown mucus adhering to walls.

Small intestine.—Duodenum congested. Haemorrhages present in its entire length. Jejunum also congested and haemorrhages present. Contents brown fluid.

Large intestine.—Normal.

Helminths.—None present.

Liver.—Weight 68 ozs. Congested. Haemorrhages present under capsule. Friable. Greasy on section.

Gall bladder.—Normal. Contents 2 ozs. normal bile.

Pancreas.—Normal. Weight 6 ozs.

Spleen.—Weight 13½ ozs. Enlarged, soft and pulpy.

Kidney, right.—Weight 6½ ozs. Congested. Capsule strips easily. Stellate veins enlarged.

Kidney, left.—Weight 6½ ozs. Same appearance as right.

Suprarenal capsules.—Normal.

Lymphatic system.—Normal.

Bladder.—Mucous membrane congested. Haemorrhages present. Contained one teaspoonful of muddy urine. Acid in reaction. Highly albuminous. Tube casts also present.

Diagnosis.—Yellow fever.

Smears from organs and specimens sent to Research Institute.

Laboratory Report

Microscopic

1. Smear preparation from :—
   (*a*) Spleen.—*Paraplasma flavigenum* present.
   (*b*) Liver.—*Paraplasma flavigenum* present.
   (*c*) Bone marrow. *Paraplasma flavigenum* present.
   (*d*) Lung.—*Paraplasma flavigenum* present.
2. Histological :—
   (*a*) Liver.—Extensive fatty metamorphosis. Lobules distorted. Small haemorrhages present. Few cells contained large fatty globules.
   (*b*) Kidney.—Fatty metamorphosis present. Tubules filled with granular and hyaline débris. Denuded of cells in places.
   (*c*) Spleen.—Congested.
3. Urine examination : Acid reaction. Highly albuminous. Tube casts present.

Case No. 30. L. 103

Sex : Male.

Age : 20 years.

Nationality : European, German.

Occupation : Fireman.

Date of admission : 26th October, 1913.

Date of discharge : 11th November, 1913.

Diagnosis : Yellow fever.

History.—This was one of the cases removed from the s.s. 'Elizabeth Brock,' and admitted to the Lagos hospital.

Patient states that he first became ill on the 24th October, complaining of headache and fever, the temperature being 103·6°. On the 25th, he felt much worse, severe frontal headache and aching pains being present in the loins and

extremities. The temperature was 98·6°. On the morning of the 26th, the temperature at 6 a.m. was 100·6°. He was admitted into hospital at 9 a.m.

On admission.—Face flushed. Conjunctivae very injected and red. Respirations were hurried. Complained of severe frontal headache and aching pains in the extremities and back.

Alimentary system.—Appetite lost. Bowels constipated. Tongue pointed and red, dorsum coated, tip and edges clear. No vomiting, nausea present. Epigastric pain and discomfort present. Liver and spleen both normal.

Circulatory system.—Heart sounds normal. Pulse slow, 86 per minute.

Respiratory system.—Lungs normal. Respirations hurried.

Nervous system.—Severe frontal headache. Aching pains in the loins and extremities. Reflexes normal.

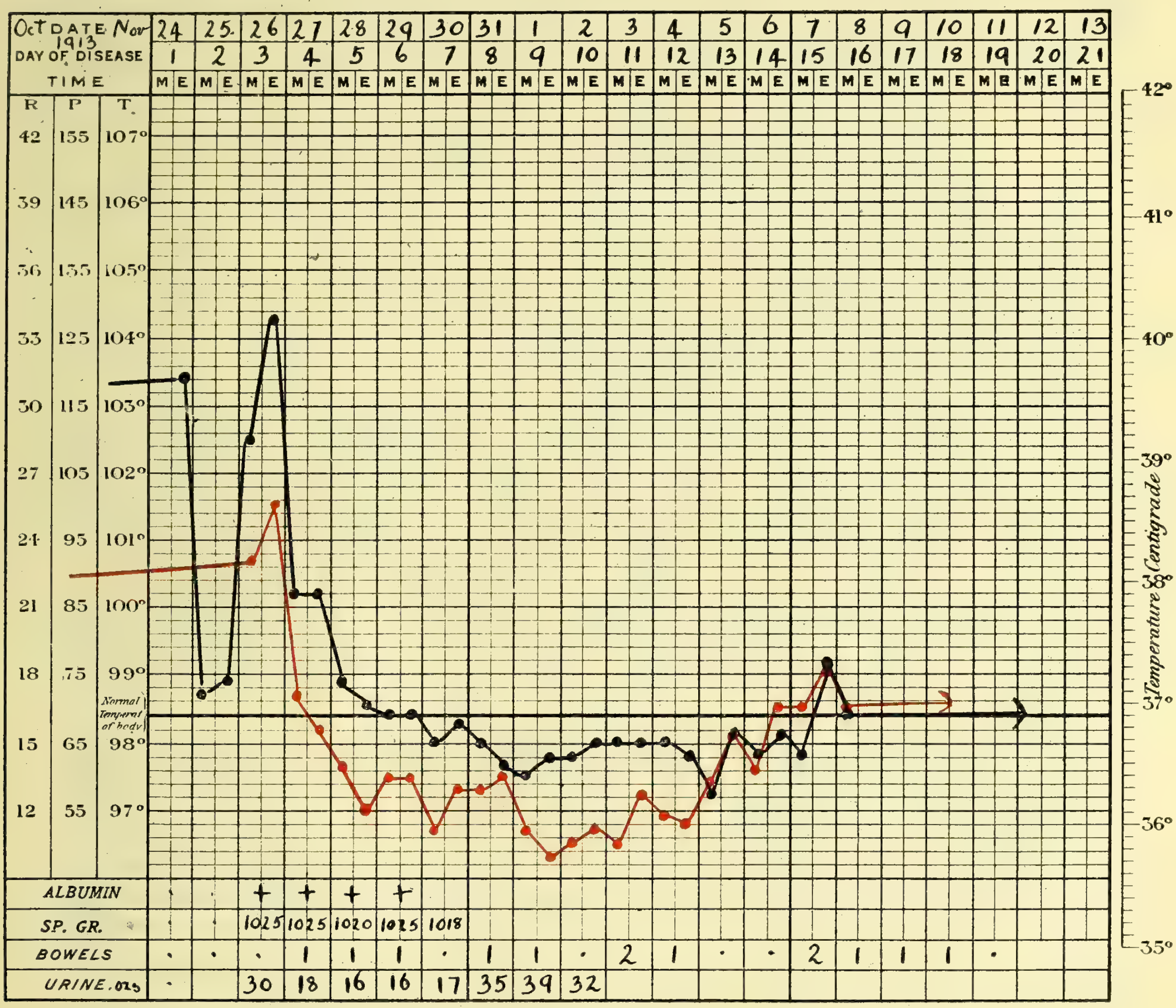


Chart 29

Urinary system.—Urine high coloured. Patient states that it is diminished in quantity. On examination: Acid reaction. Sp. gr. 1025. Albumen present.

Blood examination.—No malaria parasites present. *Paraplasma flavigenum* present. Leucopenia present. Differential count: Polymorphonuclear, 60 per cent.; mononuclear, 11·4 per cent.; lymphocytes, 18 per cent.; eosinophil, 8·8 per cent.; transitionals, 1·8 per cent.

Temperature at 8 p.m. was 104°, pulse rate 100.

27th October.—Patient had a fair night. Headache and loin pains decreased in severity this morning. Temperature at 8 a.m. 100·2°, pulse rate 72. No vomiting. Bowels opened. Has passed 39 ozs. of urine since admission, acid in reaction. Sp. gr. 1025. Albumen and tube casts present. At 8 p.m. temperature was 100·2°, pulse rate 66.

28th October.—Patient feels much better and had a good night. Conjunctival injection passed off. Sclerae are yellow. Temperature at 8 a.m. was 98·8°, pulse 62. Urine passed freely and increased in quantity. Albumen still present. Temperature at 8 p.m. was 98·6°, pulse rate 56.

Patient continued to progress favourably. Appetite returned and the bowels became regular. Urine increased and the albumen disappeared on the 30th. Jaundice gradually cleared up and disappeared on the 4th November. Urine was normal in quantity and character. The patient made an uneventful recovery and was discharged cured on the 11th November.

Case No. 31. L. 104

Sex: Male.
Age: 37 years.
Nationality: European, German.
Occupation: Fireman.
Date of admission: 26th October, 1913.
Date of discharge: 11th November, 1913.
Diagnosis: Yellow fever.

History.—This was another case off the s.s. 'Elizabeth Brock.' Patient became ill on the same day as the other man, viz., the 24th. He had rigors, headache, and pains in the back, followed by pyrexia, temperature being 101·2°. Next day he felt very much worse, headache was severe, nausea present with epigastric pain and discomfort. He was sent into the hospital with the other case, No. 30, at 9 a.m.

On admission.—Face flushed. Conjunctivae injected and red. Respirations were hurried, and patient seemed in distress. Complained of severe headache and aching pains in the loins and extremities. Temperature was 103·4°, pulse rate 82, slow and intermittent.

Alimentary system.—Appetite lost. Bowels constipated. Tongue pointed with red tip and edges, furred dorsum. Liver and spleen both normal. Nausea present with epigastric pain and discomfort. No vomiting.

Circulatory system.—Heart sounds normal. Pulse slow and intermittent.

Respiratory system.—Lungs were normal. Respirations hurried.

Nervous system.—Severe frontal headache. Aching pains in the loins and limbs. Reflexes were normal.

Urinary system.—Urine has diminished. Patient passed urine on admission. Examination: Acid reaction. Sp. gr. 1022. No albumen present.

Blood examination.—Few malaria parasites present. *Paraplasma flavigenum* present. Leucopenia present. Differential count: Polymorphonuclear, 69·2 per cent.; mononuclear, 12·5 per cent.; lymphocytes, 10·8 per cent.; eosinophil, 0·6 per cent.; transitionals, 3·2 per cent.; mast cells, 3·7 per cent.

27th October.—Patient had a bad night. Temperature 104·4°, pulse rate 82 during the night. At 8 a.m., temperature was 99·2°, pulse 56. Headache and loin pain severe; patient did not sleep. Urine is diminished, and on examination was acid in reaction. Sp. gr. 1025. Albumen and tube casts present.

28th October.—Patient had a better night, headache and loin pains not so severe. Temperature at 8 a.m. was 99·4°, pulse 64. Urine still decreased, and albumen present. Sclerae are yellow. Temperature at 8 p.m., 99·4°.

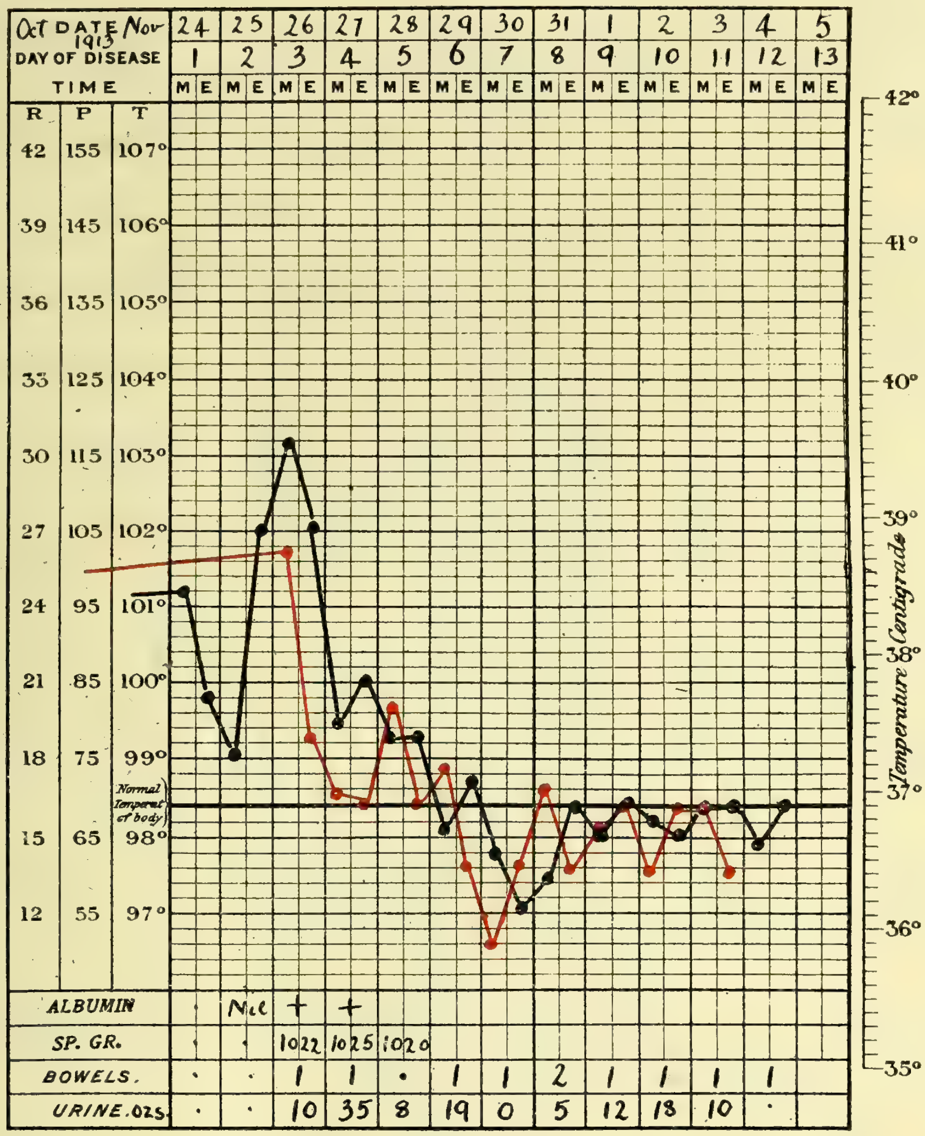


Chart 30

29th October. Patient much better, headache and pains quite gone. Nausea and epigastric discomfort also gone. Temperature normal, pulse 60. Sclerae very yellow. Urine increased, but albumen still present. Patient continued to do well, appetite returned, bowels regular. Urine returned to normal amount and albumen disappeared on the 30th, bile appearing in the urine. Jaundice disappeared on the 4th November and the patient was discharged cured on the 11th November.

Case No. 32. L. 105

Sex: Male.
Age: 27 years.
Nationality: European, British.
Occupation: Ship's Officer.
Date of admission: 26th November, 1913.
Date of death: 26th November, 1913.
Diagnosis: Yellow fever.

History.—Patient was sent into hospital at 4.15 p.m. on the 26th November from the s.s. 'Bassa.' The patient was delirious, temperature 106·8°. The vessel had arrived from Forcados on the 24th; the man had been seedy for a couple of days.

On admission.—Patient wildly delirious. Face and neck cyanosed. Pulse very quick and thready. Pupils widely dilated. Passed 4 ounces of urine after admission. Temperature in axilla, 106·8°.

Alimentary system.—Liver and spleen were normal. Tongue was pointed and red.

Respiratory system.—Respirations were rapid. Breathing stertorous.

Nervous system.—Pupils widely dilated. Delirium present.

Urinary system.—Urine was clear, reddish yellow in colour. Acid reaction. Sp. gr. 1025. No albumen present. Phosphates present.

Skin.—Skin was covered with a red rash. Face, neck and chest showed patches of cyanosis. Conjunctivae very injected. Eyes shining.

Blood examination.—Few malaria parasites present. *Paraplasma flavigenum* present. Differential count: Polymorphonuclear, 66·5 per cent.; mononuclear, 11·6 per cent.; lymphocytes, 18 per cent.; eosinophil, 0·5 per cent.; transitionals, 3·4 per cent. Patient was given an intramuscular injection of quinine, grs. 10. Wet pack.

At 5.20 p.m. temperature in axilla was 106·2°. Breathing stertorous. Face and chest cyanosed. At 5.30 patient placed in ice pack, rectal temperature 108·6°. At 6 p.m. vomiting occurred, bilious in character, and took place several times. At 6.45 p.m. rectal temperature was 105·6°, pulse had improved and was 115 per minute. Breathing easier and not stertorous. Delirium stopped and patient quiet.

At 7.45 p.m., patient in the same condition, rectal temperature 105·7°, pulse 129 per minute. Vomiting again occurred, bilious. At 8.45 p.m. patient became very restless. Rectal temperature 105·8°. Convulsions set in, and patient died at 9 p.m.

Post-mortem notes.—Autopsy was performed at 8 a.m. next morning. Skin was yellow. Ears, neck and face cyanosed. Genital organs were deeply cyanosed. Conjunctivae showed haemorrhages.

Rigor mortis.—Present.

Brain.—Vessels engorged. Brain substance congested.

Spinal cord.—Congested.

Membranes.—Congested. Vessels engorged. Dura mater adherent to calvarium. Pia and arachnoid mater adherent to brain.

Heart.—Weight 10½ ounces, pale and flabby, valves normal. Haemorrhages present on the epicardium as well as on the endocardium of the right auricle and ventricle.

Large vessels.—Normal.

Lung, right.—Weight 14½ ounces, normal, some congestion at base.

Lung, left.—Weight 12½ ounces, normal.

Pleurae.—Normal, no adhesions.

Larynx, trachea, bronchi.—Mucous membrane, slight congestion.

Peritoneum.—Normal.

Stomach.—Peritoneal surface congested. Vessels engorged. Mucous membrane congested. Rugae prominent. Large areas of haemorrhage in the posterior wall, cardiac and pyloric ends, and along the greater curvature. Contents: 1 ounce of brown fluid.

Small intestine.—Duodenum congested. Haemorrhages present in its entire

length. Jejunum and ileum presented the same condition. Contents: brown fluid.

Large intestine.—Normal.

Helminths.—None present.

Liver.—Weight 43 ounces, congested, with yellow patches. Friable, greasy on section. Haemorrhages seen under capsule.

Gall bladder.—Distended with normal bile.

Pancreas.—Normal. Weight $3\frac{3}{4}$ ounces.

Spleen.—Weight $6\frac{1}{2}$ ounces. Congested. Soft and pulpy.

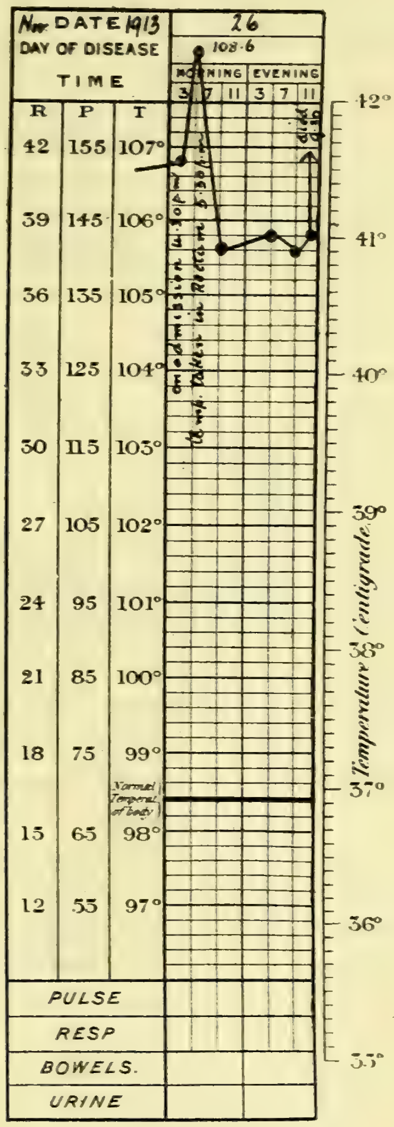


Chart 31

Kidney, right.—Weight $5\frac{1}{2}$ ounces. Very congested. Capsule strips easily. Stellate veins prominent.

Kidney, left.—Weight $5\frac{1}{2}$ ounces. Same appearance as the right.

Suprarenal capsules.—Normal.

Lymphatic system.—Normal.

Bladder.—Contracted. Mucous membrane congested and showed small haemorrhages. Contents: 3 ounces turbid urine. Acid reaction and highly albuminous.

Laboratory Report

Microscopical

1. Blood smears and smears from organs.
   (*a*) Blood. *Paraplasma flavigenum* present.
   (*b*) Heart. *Paraplasma flavigenum* present.
   (*c*) Spleen. Negative.
   (*d*) Lung. *Paraplasma flavigenum* present.

2. Histological.
   (*a*) Liver. Fatty degeneration. Small haemorrhages present.
   (*b*) Kidney. Fatty degeneration present. Tubules denuded of epithelium in places. Tubules blocked with granular and hyaline débris.

3. Urine examination: Acid reaction. Highly albuminous. Tube casts present.

Case No. 33. L. 106

Sex: Male.
Age: 38 years.
Nationality: European, British.
Occupation: Engineer.
Date of admission: 29th November, 1913.
Date of discharge: 4th December, 1913.
Diagnosis: Suspected yellow fever.

History.—Patient was sent into hospital from the s.s. 'Barro,' which had arrived from Forcados, by the Senior Sanitary Officer. He states that he became ill in Forcados four days ago with fever. Illness began with frontal headache, and aching pains in the loins and extremities. He also had nausea and epigastric pain and discomfort and this was followed by vomiting for the first three days of the illness. This day he feels better and has had no more vomiting. Bowels were constipated at the commencement of the illness but have been opened by aperients.

On admission.—Temperature was 98·8°, pulse 76. Slight frontal headache present. Skin is sallow and the sclerae are tinged with yellow.

Alimentary system.—Tongue is clean and red. Liver and spleen are both normal. No epigastric tenderness present. Vomiting has stopped.

Circulatory system.—Heart sounds are normal. Pulse 76.

Respiratory system.—Lungs normal.

Nervous system.—Slight frontal headache. Reflexes normal.

Urinary system.—Urine is high coloured. On examination: Acid reaction. Sp. gr. 1025. Albumen present, trace of bile present.

Blood examination.—No malaria parasites present. Leucopenia present. Differential count: Polymorphonuclear, 66·5 per cent.; lymphocytes, 28·5 per cent.; mononuclear, 5 per cent.

30*th November.*—Patient had a good night. Temperature at 8 p.m. last night was 99·4°, pulse 68. This morning it is 98·4°, pulse 70. Bowels were opened. No vomiting. Headache has gone. Urine showed albumen present, acid reaction and sp. gr. 1028. Sclerae are very yellow.

1*st December.*—Patient is doing well. Had a good night. Urine passed in normal quantity and albumen has disappeared. Bile present. Sclerae are yellow and skin also shows jaundice. Appetite has returned. Temperature normal.

Patient progressed favourably and the jaundice passed off on the 4th, and the patient was discharged on that date.

This case was undoubtedly one of mild yellow fever, from the history of the case and the clinical symptoms, although when sent to the Lagos hospital the patient was recovering.

Case No. 34. L. 107

Sex : Male.

Age : 41 years.

Nationality : European, British.

Occupation : Steward.

Date of death : 24th December, 1913.

Diagnosis after post-mortem : Yellow fever.

History.—The following history of the case was obtained from the captain of the vessel, as the patient had died on the way to the hospital. The deceased had been seedy for the previous two days, but had not complained. On the morning of the 24th, he complained that he felt feverish, and, his temperature being taken, it was found to be 104°. He went to bed, and a doctor was sent for. He was quite sensible and had taken some beef tea. Dr. Gray saw him at 3 p.m., and found him quite unconscious, with stertorous breathing, and with an axillary temperature of 109°. He advised his immediate removal to hospital, and death took place on the way.

Post-mortem Notes

The autopsy was performed at 5 p.m. that evening. Face, ears and neck were cyanosed. Patches of petechial eruption present on the abdomen and thighs. Genital organs cyanosed. Body was well nourished and fat.

Rigor mortis.—Had not begun.

Brain.—Vessels engorged. Brain substance congested.

Spinal cord.—Congested.

Membranes.—Vessels engorged. Membranes adherent.

Heart.—Weight, 13 ounces. Pale and flabby. Valves normal.

Large vessels.—Aorta showed a patch of atheroma.

Lung, right.—Weight, 16 ounces. Congested at base.

Lung, left.—Weight 17 ounces. Very congested at base.

Pleurae.—Normal. No adhesions.

Larynx, trachea, bronchi.—Mucous membrane congested.

Peritoneum.—Normal. Very fatty.

Stomach.—Peritoneal surface congested. Vessels prominent and engorged. Mucous membrane congested. Rugae swollen. Haemorrhages present at cardiac and pyloric ends, also on posterior wall and along the greater curvature. Stomach was empty.

Small intestine.—Duodenum congested. Haemorrhages present in its entire length. Jejunum also congested and submucous haemorrhages present. Ileum congested.

Large intestine.—Normal.

Helminths.—None present.

Liver.—Weight 82 ounces. Left lobe yellow. Right lobe very congested. Haemorrhages present under capsule. Very friable. Greasy on section.

Gall bladder.—Normal.

Pancreas.—Weight 5 ounces. Normal.

Spleen.—Weight 4 ounces. Soft and pulpy.

Kidney, right.—Weight 7 ozs. Congested. Capsule strips readily. Cortex congested.

Kidney, left.—Weight $7\frac{1}{2}$ ozs. Very congested. Capsule strips easily.

Suprarenal capsule.—Normal.

Lymphatic system.—Normal.

Bladder.—Normal. Contained 3 ozs. of urine. Urine was acid in reaction and albuminous.

Laboratory Report

Microscopical

1. Blood and smears from organs :—
   (*a*) Blood : *Paraplasma flavigenum* present.
   (*b*) Spleen : Negative.
   (*c*) Liver : *Paraplasma flavigenum* present.
   (*d*) Kidney : Negative.

2. Histological—
   (*a*) Liver : Fatty degeneration present and extensive. Haemorrhages present.
   (*b*) Spleen : Normal.
   (*c*) Kidney : Fatty metamorphosis. Tubules filled with granular and hyaline débris. Cells of convoluted tubules swollen and granular.

3. Urine examination : Acid reaction. Albumen present. Tube casts also present.

Case No. 35. L. 119

Notes by Dr. Manson.

Sex : Male.
Age : —
Nationality : European, British.
Occupation : Ship's Officer.
Date of death : 28th December, 1913.
Diagnosis after post-mortem : Yellow fever.

Dr. Manson reports that he was called to see this patient on the afternoon of the 28th, the vessel lying in the Lagos Roads. On his arrival he found the patient unconscious and in convulsions, and death occurred in his presence about 5 p.m.

The following history was obtained from the captain of the vessel. The deceased had complained of fever on the 25th December, and his temperature was 102°. On the 26th, at 10 a.m., it was 103°. On the 27th, the morning temperature was 103°, and at 6 p.m. it had risen to 105·4°. On the 28th, at 2 a.m. it was 105·4°, at 9 a.m. 103·4°, and at 4 p.m. it had risen to 106°. At 4.30 p.m. patient had vomited some black-looking fluid. Temperature taken just before death was 106°, and the pulse rate 70.

Post-mortem Notes

Autopsy was performed by Dr. Manson at 7 a.m. next morning.

Rigor mortis was well marked. Petechial patches on the neck and chest. Genital organs cyanosed.

Kidneys.—Enlarged. Capsules strip easily.

Spleen.—Enlarged and soft.

Liver.—Size normal, paler than normal.

Stomach and duodenum.—Removed *en masse.* Stomach contained some greenish-black fluid which looked like altered blood. Haemorrhages present in the M. membrane of the greater part of the stomach and duodenum.

Bladder.—Contracted but contained a small amount of urine, which was drawn off and on testing was found to contain albumen.

Portions of spleen, liver and kidney, together with smears and the whole of the stomach and duodenum, were sent to the Medical Research Institute, Yaba, for further examination and report.

Diagnosis : Yellow fever.

Laboratory Report

None received.

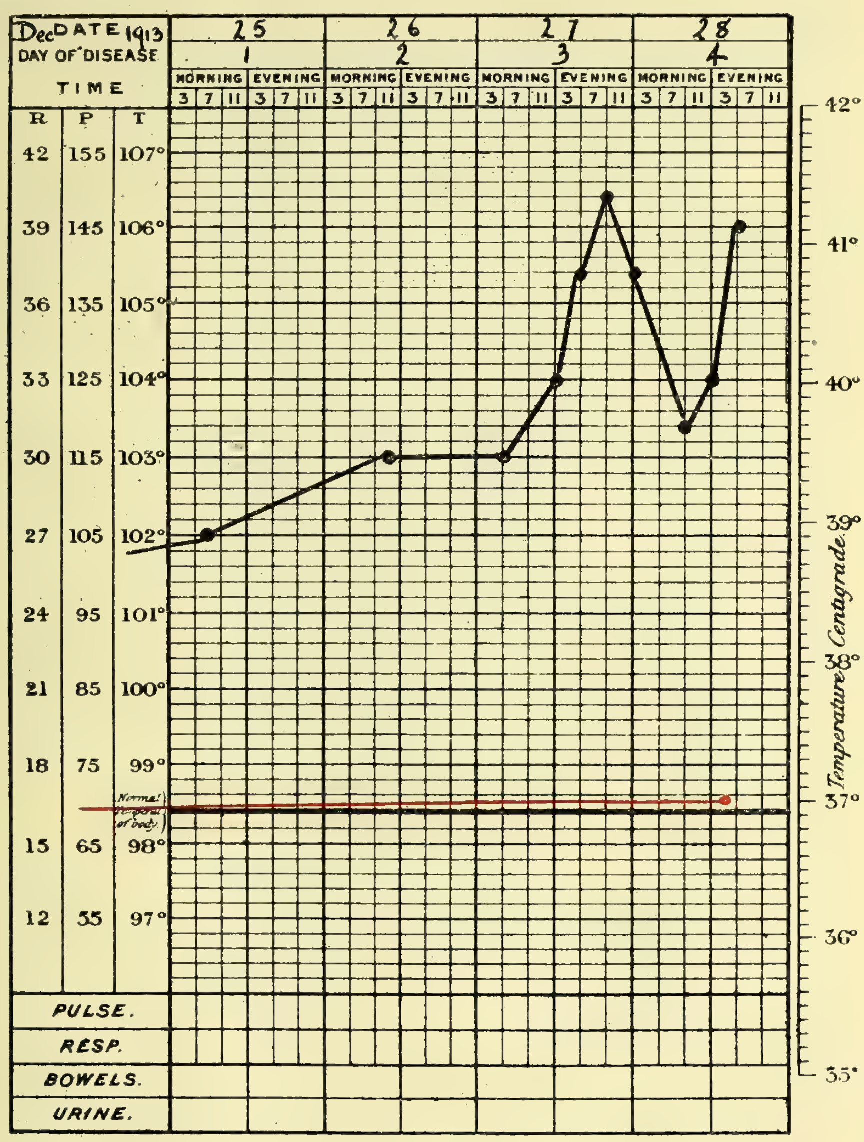


Chart 32

Note—With the exception of the pulse record on the day of death (made by the Medical Officer, Lagos) this chart was compiled from observations made by the Captain of the vessel.

According to the Captain's statement the pulse-rate had never been more than 80 per minute.

Case No. 36. L. 113

Reported by Dr. Bailey

Sex: Male.
Age: 32 years.
Nationality: European, British.
Occupation: Ship's Officer.
Date of death: 18th October, 1913.
According to the statements of the ship's surgeon, illness began on 9th October.

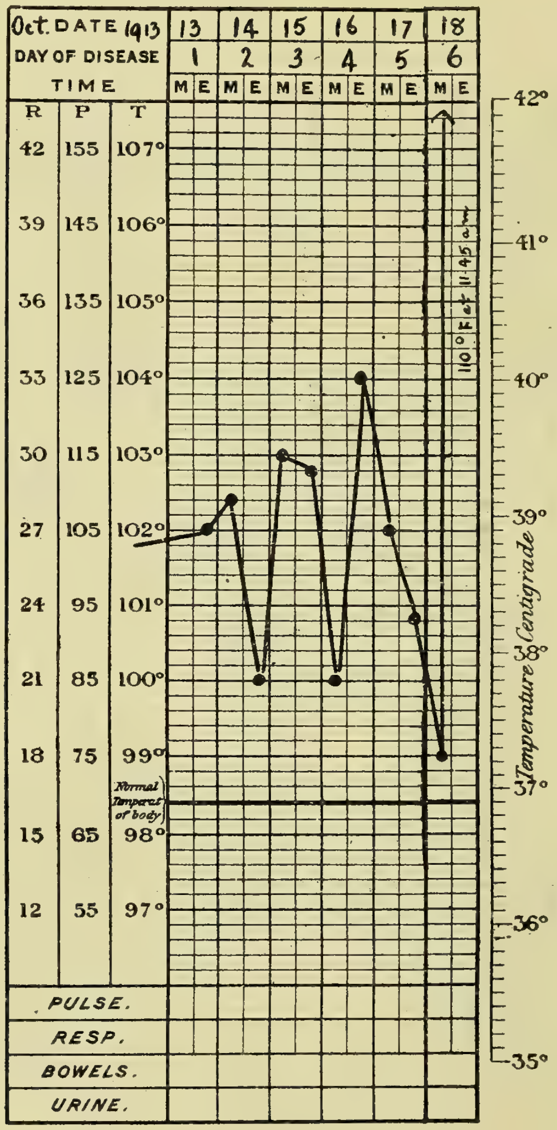


Chart 33

Previous history.—To the doctor's knowledge, the patient had not suffered much, if at all, from fever. He had had a cough for some time, and just before his last illness an injury to his shoulder.

Present illness.—The ship's doctor says there was no albuminuria or haematuria. Patient vomited once the day before his death. He vomited immediately before death and brought up a quantity of bad smelling, reddish-brown stuff. Patient

complained of pain in the belly on the last day. There was some tenderness in the epigastrium. Bowels were constipated. No jaundice or haemorrhages were seen. Delirium occurred at the end. Treatment: Quinine.

Post-Mortem Notes

Autopsy was made on the afternoon of the 18th October.
Sallow complexion, said to be habitual.
Conjunctivae. Slight yellow tinge.
Very marked lividity on the top of chest and shoulders. Less on back.
Lungs.—Intensely congested, both lungs aerated.
Pleurae.—Some adhesions in right pleura.
Heart.—Large and flabby, blood-stained.
Liver.—Dull yellow box-wood colour. Left lobe most typical. Right lobe covered with small dilated vessels. Normal or slightly reduced in size. Fatty.
Spleen.—Enlarged, congested and diffluent.
Stomach.—Contents: 8 ozs. bloody fluid, reddish-brown colour. Not coffee ground. Part of stomach wall most intensely congested.
Small intestine.—Normal in appearance with a few areas of congestion. Contents: yellow fluid with admixture of flakes of dark mucus.
Large intestine.—Normal. Evidence of old inflammation around appendix, with enlarged glands.
Kidneys.—Much congested, especially the left. Capsule separated with difficulty.
Brain.—Vessels on surface congested, with dark blood. Vessels in brain matter show as small red dots.
Urine.—No specimen kept.

Laboratory Report

None received.

Specimens were sent to the Research Institute, Yaba.

Case No. 37

Sex: Male.
Age: No record.
Nationality: European, British.
Occupation: Ship's Officer.
Date of death: 23rd October, 1913.
The following report of this case was sent in by the surgeon of the vessel.

'On Monday, the 20th of October, at 10.40 a.m., the deceased reported sick. On examination, I found that his temperature was 105°, no headache or any other symptom complained of. He was placed in hospital on the ship, phenacetin and caffeine being administered. Diet: milk and soda. Temperature became normal about 11 p.m., when 20 grains of quinine were given by the rectum, patient being unable to take quinine by mouth.

From above date and hour (11 p.m.) temperature remained normal

until the evening of the 22nd, when it rose to 101°, but was reduced at 11 p.m. to normal.

On the morning of the 23rd I was sent for by the night attendant at the hospital. I found the patient slightly delirious, head very hot, temperature 103°. I placed calves of legs in flannel steeped in mustard and water and administered brandy, heart's action being very weak. Temperature rising at 6 a.m. to 104° and delirium increasing, I blistered behind the ears. At 7.15

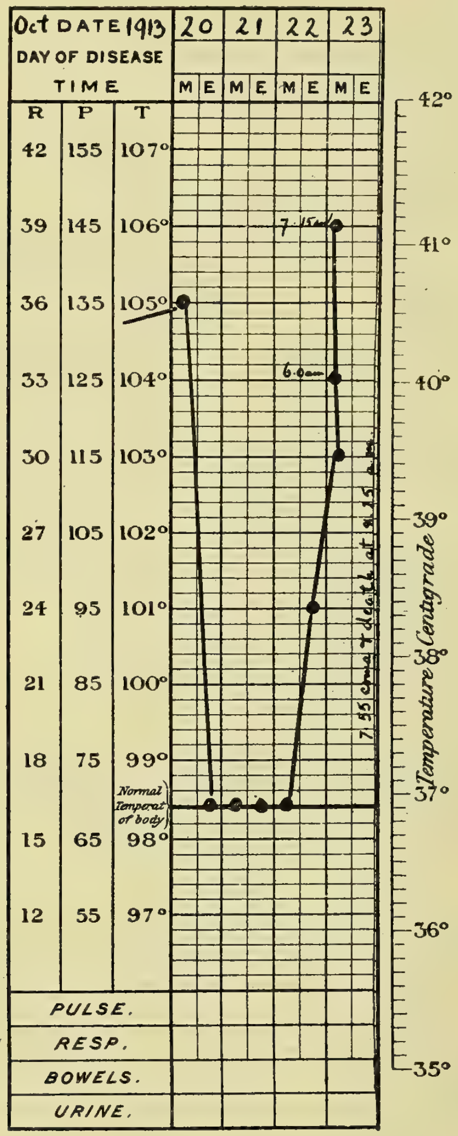


Chart 34

a.m. temperature was 106·5°. I had a consultation with Dr. O'Keefe, Medical Officer, Government Service. Mustard was placed beneath heart and strychnine injected, but without avail, patient became comatose at 7.55 and passed away at 8.25 a.m.

Diagnosis.—Hyperpyrexia during malarial fever.'

This case is one that must be viewed with great suspicion, as being one of yellow fever and not simple malarial fever. Unfortunately, there are no data on

which any reliance can be placed in order to permit of a diagnosis being made from the above report. There are no records of blood examination, urine examination, pulse rate, and, finally, no post-mortem examination was made of the body in order to confirm the diagnosis. The deceased became ill in Forcados, a port in which yellow fever was known to exist. Illness was very sudden, temperature high, and vomiting apparently was present, as quinine could not be taken by the mouth. Presuming that the quinine treatment was carried on during the two days preceding death, there seems to be no reason for the hyperpyrexia, delirium, coma and death other than that the illness was complicated with yellow fever as well as malaria, as, from my experience of malarial fevers in West Africa and in the West Indies, quinine properly administered cuts short the attack of malarial fever.

Cases quoted in this report show that yellow fever can exist side by side in the same individual as malarial fever, and in the above case there seems to be very little doubt that the cause of death was yellow fever.

Case No. 38

Sex: Male.

Age: 21 years.

Nationality: European, Russian Finn.

Occupation: Fireman.

Date of admission: 26th October, 1913, Calabar Hospital.

Date of discharge: 15th November, 1913.

Diagnosis: Yellow fever.

The following report of the case was received from Dr. Adam, Calabar.

No history of the case was available as the patient spoke neither English, German nor French. No interpreter was available.

General appearance.—Face slightly flushed. Conjunctivae injected.

Digestive system.—Tongue was furred, with red edges. Epigastric tenderness present. Nausea present, especially at first. Vomiting present. Bilious character. Stools, no special character.

Pulse and respiration.—Faget's sign present.

Nervous system.—No nervous symptoms.

Urine.—Quantity diminished. Albumen appeared on the 3rd day. Bile pigment, slight.

Skin.—No rash. Sweating.

Haemorrhages.—Nil.

Blood examination.—No malaria parasites. *Paraplasma flavigenum* present.

No further history could be obtained. Patient made an uneventful recovery, and was discharged cured on the 15th November.

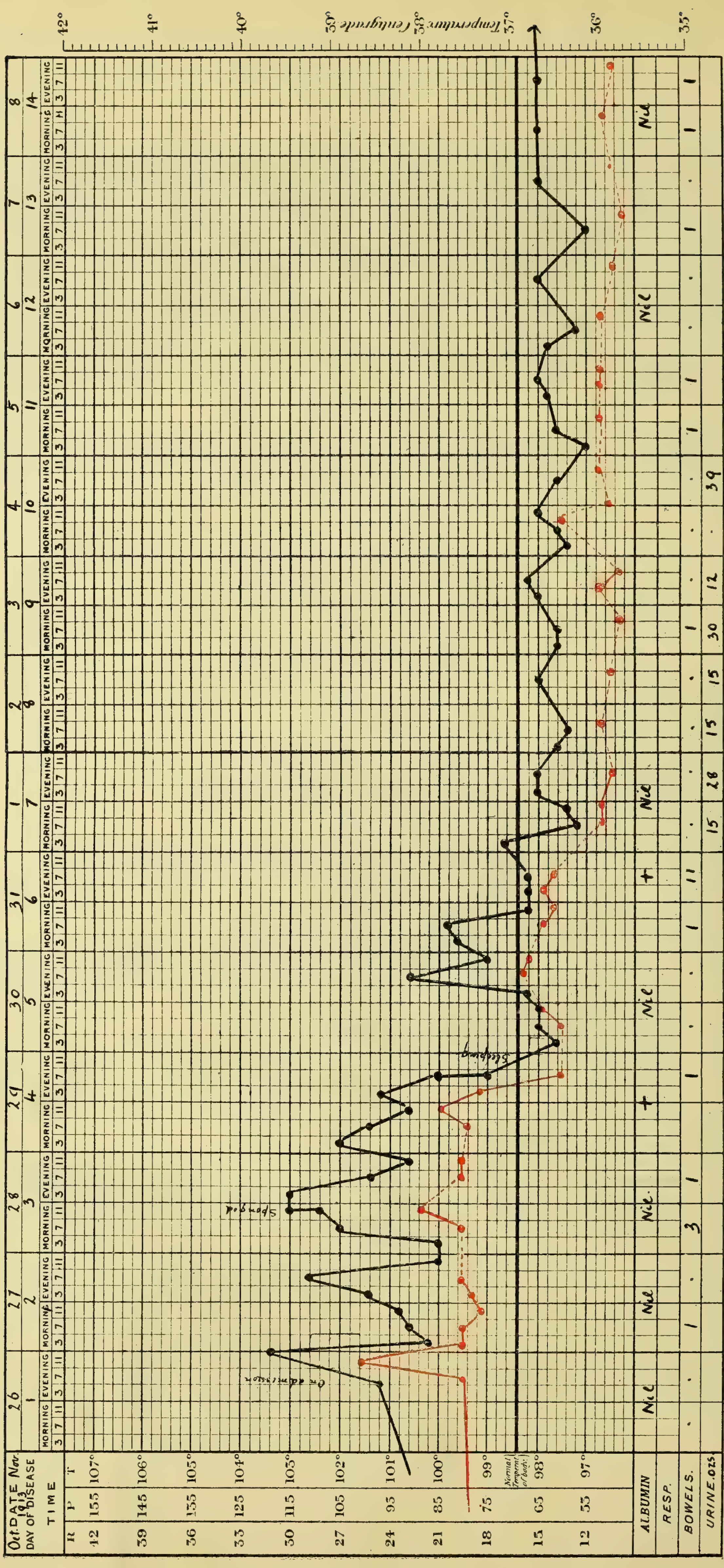

Oct. DATE Nov. 1913
DAY OF DISEASE
TIME
Temperature Centigrade
On admission
Sponged
Sleeping
ALBUMIN
RESP.
BOWELS.
URINE.

Chart 35

Synopsis of the Cases

The onset was:—

(*a*) Sudden in Cases 2, 5, 7, 8, 9, 10, 11, 12, 14, 15, 16, 18, 19, 22, 23, 26, 27, 29, 30, 31, 32, 34.

(*b*) Gradual in Cases 1, 3, 4, 6, 13, 17, 20, 21, 24, 25, 28, 33, 36.

(*c*) Accompanied by rigors in Cases 2, 4, 16, 22, 26, 31.

(*d*) Accompanied by chills in Cases 7, 8, 9, 10, 12, 17, 18, 19, 24, 25.

(*e*) Accompanied by high temperature in Cases 1, 3, 5, 6, 11, 20, 21, 23, 27, 28, 29, 30, 32, 34, 35, 37.

The fever and pulse:—

Faget's sign was noted in Cases 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 30, 31, 33, 35, 38. No record in Cases 29, 34, 36, 37.

The face was flushed in Cases 1, 6, 7, 8, 9, 11, 14, 28, 30, 31, 38.

Cyanosed in Cases 29, 32, 34.

No record in Cases 35, 36, 37.

The remaining cases being negroes, this sign could not be noticed.

The eyes:—

(*a*) Conjunctivae injected in Cases 2, 3, 4, 6, 8, 12, 15, 17, 20, 21, 23, 26, 27, 28, 30, 31, 38.

(*b*) Conjunctivae injected, eyes shining, in Cases 1, 7, 9, 10, 11, 13, 14, 18, 19, 22, 24, 25.

(*c*) Sclerae jaundiced in Cases 1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 30, 31, 38.

(*d*) Photophobia and intolerance of light in Cases 1, 32.

(*e*) Haemorrhages into conjunctivae in Case 7.

(*f*) Pupils dilated and not reactive to light in Case 32.

(*g*) Pupils dilated and not reactive to light in Cases 7, 8, 11, before death.

The skin:—

(*a*) Jaundice noted in Cases 1, 7, 8, 9, 11, 14, 28, 30, 31, 33, 36 and 38.

(*b*) Erythematous rash noted in Cases 7, 32.

(*c*) Petechial haemorrhages in Cases 1 and 7.
(*d*) Jaundice after death in Cases 29, 32, 34 and 35.
(*e*) Cyanosis of skin in Cases 29, 32, 34.

The Nervous System

Cerebral symptoms:—

(*a*) Restlessness noted in Cases 1, 2, 3, 4, 8, 11, 15, 18, 19, 20, 22, 23, 24, 26, 27, 28, 31.
(*b*) General distress in Cases 2, 3, 4, 5, 6, 8, 9, 11, 12, 13, 14, 15, 16, 19, 20, 24, 25.
(*c*) Delirium in Cases 7, 8, 10, 32.
(*d*) Insomnia in Cases 11, 12, 14, 15, 16, 18, 20, 22, 24, 26, 27, 31.
(*e*) Coma in Cases 1, 11.
(*f*) Convulsions in Cases 7, 8, 32.
(*g*) Subsultus tendinum in Cases 1 and 7.

Disorders of sensation:—

(*a*) Thirst noted in Cases 1 and 2.
(*b*) Deafness in Case 6.

Pain:—

(*a*) Frontal headache in Cases 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 30, 31.
(*b*) Frontal headache very severe in Cases 1, 5, 7, 8, 9, 11, 20.
(*c*) Ocular pain in Cases 1, 7, 9.
(*d*) Occipital headache in Cases 6, 20, 22.
(*e*) Epigastralgia noted in cases 1, 2, 3, 5, 6, 7, 8, 9, 10, 11, 13, 14, 18, 20, 23, 24, 25, 26, 27, 28, 30, 31.
(*f*) Pain over liver in Case 5.
(*g*) Pain over spleen in Cases 5, 12, 14, 16, 23.
(*h*) Pains in loins in Cases 5, 7, 8, 10, 11, 12, 13, 14, 15, 17, 18, 19, 20, 22, 23, 24, 25, 26, 27, 28, 30, 31.
(*i*) Pains in the back in Cases 9, 10, 11, 15, 16, 18, 21.
(*j*) Pain in extremities in Cases 4, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 30, 31.
(*k*) Pains all over the body in Cases 1, 2, 3, 4.

The Digestive System

The mouth:—

(*a*) Foetor of the breath noted in Cases 1, 7, 8, 11.

(*b*) Gums red and swollen in Cases 9, 14, 18, 19, 21, 24, 25, 26.

The tongue:—

(*a*) Furred only in Cases 16, 22.

(*b*) Furred with tip and edges clean in Cases 4, 5, 6, 17, 23, 27.

(*c*) Pointed with white dorsum and red tip and edges in Cases 1, 2, 3, 7, 8, 9, 10, 11, 12, 13, 14, 15, 18, 19, 20, 21, 24, 25, 26, 28, 30, 31.

Nose and throat:—

(*a*) Pharynx red and inflamed in Cases 6 and 22.

(*b*) Epistaxis occurred in Case 8.

Stomach:—

(*a*) Nausea present in Cases 6, 7, 8, 9, 11, 12, 13, 18, 20, 21, 22, 24, 25, 26, 27, 28, 30, 31.

(*b*) Vomiting occurred in Cases 1, 4, 6, 7, 8, 9, 11, 22, 25, 32.

(*c*) Retching present in Case 25.

(*d*) Black vomit occurred in Cases 1, 7, 8, 11, 35.

(*e*) Reddish brown vomit in Case 36.

(*f*) Hiccup present in Cases 1 and 8.

Stools:—

(*a*) Constipation present in Cases 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 23, 24, 27, 28, 30, 31, 38.

(*b*) Diarrhoea present in Case 22.

(*c*) Melaena and haemorrhage present in Cases 1, 7, 8, 11.

Liver:—

(*a*) Enlarged in Case 1.

(*b*) Tender in Cases 5 and 6.

Spleen:—

(*a*) Enlarged in Cases 3, 5, 8, 10, 11, 12, 18, 26.

(*b*) Tender in Cases 5, 8, 12, 14, 16, 17, 23.

The Circulatory System

Pulse:—

(*a*) Slow (Faget's sign) in Cases 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 30, 31, 33, 35, 38.

(*b*) Rapid in Case 32.

Blood examination:—

(*a*) Malaria (aestivo-autumnal) parasites present in Cases 6, 10, 13, 15, 16, 17, 21, 24, 26, 27, 31, 32.

(*b*) *Paraplasma flavigenum* present in Cases 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 30, 31, 32.

(*c*) Mononuclear increase present in Cases 1, 11, 13, 15, 17, 20, 21, 22, 23, 24, 25, 26, 27, 28, 30, 31, 32.

(*d*) Pigmented leucocytes present in Cases 5, 7, 8, 9, 11, 12, 13, 15, 17, 18, 21.

(*e*) Leucocytosis present in Case 16.

The Renal System

Urine:—

(*a*) Acid reaction in Cases 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 30, 31, 32, 38.

(*b*) Diminished at first and gradually returning to normal in Cases 2, 3, 4, 5, 6, 9, 10, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 30, 31.

(*c*) Suppressed in Cases 1, 7, 8, 11, 34.

(*d*) Albuminuria present on admission to hospital in Cases 1, 2, 3, 4, 5, 6, 7, 9, 10, 12, 13, 15, 17, 18, 19, 21, 24, 25, 28, 30, 38.

(*e*) Albuminuria appeared twelve hours after admission in Cases 8, 14, 16, 20, 22, 23, 26, 27, 31, 32.

In all the cases that recovered, the albuminuria gradually diminished and disappeared on the 6th to the 8th day, bile making its appearance.

(*f*) Tube casts were found in Cases 9, 11, 24, 25, 30, 31.

(*g*) Colour was yellow in Cases 8, 10, 11, 13, 14, 15, 16, 17, 20, and 31.

(*h*) High coloured in Cases 3, 4, 5, 6, 18, 19, 23, 24, 25, 26, 27, 28, 30, 32, 38.

(*i*) Colour was dark red in Cases 2 and 12.

(*j*) Urine was cloudy and turbid in Cases 1, 7, 9.

In cases 29, 32, 34, 35, the urine removed from the bladder at the post-mortem examination was found to be acid in reaction and highly albuminous.

Synopsis of Post-Mortem Examinations

General appearance of the body:—

(*a*) Jaundice present deeply in Cases 1, 7, 8, 11.
(*b*) Jaundice present slightly in Cases 29, 32, 35, 36.
(*c*) Jaundice absent in Case 34.
(*d*) Cyanotic areas present in Cases 1, 8, 29, 32, 34.
(*e*) Cyanosis and ecchymoses of the genital organs present in Cases 1, 7, 8, 11, 29, 32, 34, 35.
(*f*) Hypostatic congestion of dependent parts present in Cases 1, 7, 8, 11, 29, 32, 34, 35.
(*g*) Subconjunctival haemorrhages present in Cases 7 and 32.
(*h*) Petechial haemorrhages present in Cases 7, 8, and 34.

The Nervous System

Brain:—

(*a*) Congested and vessels engorged in Cases 32, 34.

Membranes:—

(*a*) Congested and vessels engorged in Cases 32, 34.

The Circulatory System

Heart:—

(*a*) Pale and flabby in Cases 1, 7, 8, 11, 29, 32, 34, 35, 36.
(*b*) Valves were normal in Cases 1, 7, 11, 29, 32, 34, 35.
(*c*) Valves were diseased in Case 8.

Pericardium:—

(*a*) Contained fluid in Cases 1, 7, 8, 11.
(*b*) Haemorrhages present in Case 8.

Haemorrhages:—

(*a*) Present in skin in Cases 7, 8, 34.
(*b*) Present in conjunctivae in Cases 7, 32.
(*c*) Present in epicardial surface in Cases 8, 11, 32.
(*d*) Present in endocardium in Cases 11 and 32.
(*e*) Present in the stomach in Cases 1, 7, 8, 11, 29, 32, 34, 35, and 36.
(*f*) Present under capsule of liver in Cases 11, 29, 32, 34.
(*g*) Present in duodenum in Cases 1, 7, 8, 11, 29, 32, 34, 35.
(*h*) Present in the jejunum in Cases 1, 7, 8, 11, 29, 32, 34, and 35.

(*i*) Present in the ileum in Cases 1, 7, 8, 11, 32, 34, 35.
(*j*) Present in the large intestine in Cases 7 and 8.
(*k*) Colon congested in Case 11.
(*l*) Present in kidneys in Case 11.

The Ductless Glands

Spleen:—
(*a*) Enlarged in Cases 7, 8, 11, 29.
(*b*) Congested in Cases 1, 7, 8, 11, 29, 32, 34, 35.
(*c*) Soft and pulpy in Cases 29, 32, 34.
(*d*) Friable in Case 1.
(*e*) Firm in Case 11.

Suprarenal capsules:—
Appeared to be normal in all the cases.

Lymphatic system:—
Normal in all the cases.

The Digestive System

Stomach:—
(*a*) Mucous membrane congested in Cases 1, 7, 8, 11, 29, 32, 34.
(*b*) Rugae swollen and prominent in Cases 1, 7, 8, 11, 29, 32, 34.
(*c*) Vessels engorged and prominent in Cases 29, 32, 34.
(*d*) Haemorrhages present in Cases 1, 7, 8, 11, 29, 32, 34, 35, 36.

Small Intestine:—
(*a*) Mucous membrane congested in Cases 1, 7, 8, 11, 29, 32, 34, 35.
(*b*) Haemorrhages present in Cases 1, 7, 8, 11, 29, 32, 34, 35.
(*c*) Contents—black, tarry matter in Cases 1, 7, 8, 11, 29, 32, 34, and 35.
(*d*) Contents—brown fluid in Case 29.
(*e*) Contents—reddish-brown fluid in Case 36.

Liver:—
(*a*) Enlarged in Cases 29, 34.
(*b*) Yellow and fatty in Cases 1, 7, 8, 11, 32, 34, 35.
(*c*) Hyperaemia in Case 29.
(*d*) Haemorrhages under capsule in Cases 8, 11, 29, 32, 34.

Gall Bladder:—

(*a*) Normal in Cases 1, 11, 29, 32, 34.
(*b*) Empty in Case 7.
(*c*) Mucous membrane congested in Cases 7 and 8.

Pancreas:—

Normal appearance in all the cases.

The Genito-Urinary System

The Kidneys:—

(*a*) Enlarged in Cases 1, 7, 11, 35, 36.
(*b*) Congested in Cases 8, 11, 29, 32, 34, 36.
(*c*) Capsule strips readily in Cases 1, 7, 8, 11, 29, 32, 34, 35.
(*d*) Capsule adherent in Case 36.
(*e*) Haemorrhages present in Case 11.
(*f*) Stellate veins dilated in Cases 7, 29, 32.

Bladder:—

(*a*) Mucous membrane congested in Cases 29 and 32.
(*b*) Submucous haemorrhages present in Cases 29 and 32.
(*c*) Contracted and containing a little urine in Cases 1, 7, 8, 11, 29, 32, 34.
(*d*) Urine highly albuminous and acid in reaction in Cases 1, 7, 8, 11, 29, 32, 34.

The Respiratory System

Lungs:—

(*a*) Congested in Cases 1, 7, 8, 11, 29, 34.
(*b*) Haemorrhagic areas present in Case 7.
(*c*) Oedematous in Cases 8 and 11.
(*d*) Normal in Case 32.

Pleurae:—

(*a*) Old adhesions present in Case 11.
(*b*) Fluid in cavity in Cases 7, 8, and 11.
(*c*) Normal in Cases 1, 29, 32, 34, 35, 36.

From the tabular statement it will be seen that 18 of the total cases are non-immunes, 15 of these being Europeans and 3 Syrians. All these cases presented the typical picture of yellow fever, both in the clinical symptoms and in the post-mortem appearances of those with a fatal termination. Of the total number, thirteen were seafaring men, three were residents of Lagos and had been so for at least six months prior to their infection, and one case came from Abeokuta, a native inland town. This patient had not been in or near Lagos for a period of twenty-two months, and the conclusion to be drawn is that yellow fever was present among the natives. An important point to be noted is that all these cases have occurred among the mercantile, trading, and seafaring communities. Amongst the latter infection had been contracted at other ports of the Colony as well as Lagos, sailors being very careless livers ashore. The mercantile and trading communities are brought into closer touch with the native, their quarters are situated nearer the native element, and they are also by no means careful about the use of a mosquito-net. No case occurred among the European officials, whose quarters are for the most part mosquito-proofed and further removed from the native town. They also use mosquito-nets at night in those quarters that are not mosquito-proofed. The three Syrians who were infected were all recent arrivals in the Colony, and in the case of one, No. 8, a history of a previous attack and recovery from yellow fever in Brazil is given, but immunity had been lost by residence in Europe before coming to the Coast.

In all the cases Faget's sign was present, viz., a falling pulse or a low pulse with a rising or high temperature. This, in conjunction with the presence of albumen in the urine and epigastralgia, distinguishes these cases from the bilious remittent fever and from pappataci fever.

I have seen bilious remittent fever in the West Indies and here in Nigeria, and, as malarial infection may, and in the above cases does, co-exist with yellow fever, it is necessary to be careful and not deny the possibility of a case of bilious remittent fever, due to malaria, being at the same time one of infection with yellow fever. While both diseases may thus co-exist in the same individual, yet either disease can be clinically diagnosed with a fair amount of

certainty if the symptoms are carefully considered, particularly in non-immune Europeans or Syrians.

In bilious remittent fever I have noted the following chain of symptoms: *a*, initial chills or rigors; *b*, rising temperature with a rising pulse rate; *c*, frontal headache; *d*, aching pains in the loins and extremities; *e*, flushed face with conjunctival injection; *f*, furred tongue with constipation; *g*, epigastralgia with vomiting (the vomiting may be, and very often is, severe and continuous, and blood may even be present, but this is purely mechanical from the violent straining, and there is no tendency to haemorrhage as is seen in yellow fever); *h*, urine is very high coloured and non-albuminous; *i*, tenderness over the spleen is present and often over the liver as well; *j*, blood examination shows the presence of numerous parasites. The hypodermic administration of quinine cuts short the disease.

Comparing these symptoms with those described in the above cases, it will be seen that the chief differential characteristics of yellow fever are as follows:—

1. The rising temperature with a slow or falling pulse rate.
2. The appearance of albumen in the urine on the 2nd day of the disease and its disappearance about the 6th to 8th day.
3. Haemorrhages from the mucous membranes, chiefly from the stomach and intestinal tract, and in one of the cases (No. 8) from the nasal and oral mucous membranes. There is also a tendency to haemorrhages from the gums.
4. The characteristic tongue, pointed, with furred dorsum and red tip and edges, as compared with the thickly-coated and indented tongue of malarial fever.
5. The presence of the *Paraplasma flavigenum* of Seidelin in these cases.

In pappataci fever, of which I have had several cases here in Lagos, we also have a pyrexia ushered in with violent headache, chiefly frontal and orbital, aching pains in the muscles of the limbs, epigastralgia, pain in the peroneal and intercostal nerves, flushed face with conjunctival injection, the injection taking the form of a red band across the eyes. Vomiting and diarrhoea are present in most cases and are often the initial symptoms. An

important symptom is the presence of a pharyngitis; epistaxis very often occurs. The temperature and pulse both rise and, as the temperature falls, a typical bradycardia is established, with a slow return to normal conditions during convalescence. The urine is high coloured but contains no albumen. There is no tendency to haemorrhages from the stomach or intestinal tract. Comparing these symptoms with those of the cases quoted, there is a marked difference, but as atypical cases of both diseases may occur, and bear a resemblance, too great stress must not be laid on the symptoms of individual cases, but it is the general type of case that will determine the disease when appearing in epidemic form.

Among the natives the following clinical symptoms were present:—

(*a*) Sense of chilliness with alternating heats and in some cases rigors.
(*b*) Severe frontal headache.
(*c*) Aching pains in the loins and extremities.
(*d*) Conjunctival injection with a shining and watery appearance of the eyes.
(*e*) Hurried respirations and general distress of the patient.
(*f*) The presence of epigastralgia, increased on pressure.
(*g*) Nausea, and in some cases vomiting.
(*h*) A rising temperature or a high temperature with a slow pulse.
(*i*) The appearance of albumen in the urine on the 2nd day, which persists until the 6th to the 8th day, the amount of albumen increasing the first two or three days with the diminution in the amount of urine and its gradual disappearance as the urine returns to the normal amount.
(*j*) The appearance of jaundice, usually observed in the sclerae, and its disappearance with convalescence.
(*k*) Blood examination presented the following:—
  1. Presence of malaria parasites in very many of the cases.
  2. A leucopenia at the commencement of the disease, followed by a leucocytosis as recovery took place.
  3. Differential blood count showed in all cases a mononuclear increase.

4. An eosinophilia was also present in the native cases, and this can be accounted for by the presence of intestinal parasites, the ova being present in all the examinations of the faeces. The ova of *Ascaris* and *T. dispar* were found in all the cases, while ankylostomes were also present in eight cases and tapeworm in three.

(*l*) No deaths occurred among the natives.

In these native cases it will be seen that haemorrhages were absent, except in one, in which there was some haemorrhage from the stomach. The gums were swollen and red in the native cases as well as the European, but in the former there was no tendency to bleed as there was in the latter. The toxaemia in the native cases was therefore apparently much less than in the non-immunes, in whom the virus gained in intensity and produced the severer types of the disease. Among the natives, as far as has been seen in these outbreaks, the typical picture of yellow fever as presented by the non-immunes cannot be looked for in every case, but in my opinion the clinical picture presented by this series of cases is quite conclusive, and the following symptoms are diagnostic of the disease:—

1. Severe frontal headache.
2. Aching pains in the loins and extremities.
3. Epigastralgia.
4. Conjunctival injection.
5. High temperature with a low pulse rate.
6. Albuminuria beginning on the 2nd day and disappearing about the 6th to the 8th day, with the appearance of bile in the urine, and jaundice.
7. Nausea or vomiting.
8. General distress of the patient out of proportion to the temperature is often characteristic.

The question now arises, 'Is yellow fever endemic in Nigeria, apart from the remainder of the West Coast?' Taking into consideration the evidence collected by the late Sir Rubert Boyce, we must conclude that it is, and this series of undoubted cases of yellow fever quoted by me supports and strengthens that view. These cases occurred not only among the non-immunes but also in

the natives, though in the latter the disease was not so virulent, thus pointing to the existence of an immunity among them. With regard to the Lagos cases, it is absolutely certain that none of these cases were importations from outside the Colony, and two of the cases in Lagos were infected, not on the sea coast, but in native inland towns, viz., Abeokuta and Ogbomosho.

There is no doubt that the disease was not recognized in the past, and that the severer forms were confused with the malignant types of malaria seen on the coast, while the milder forms in the native were not taken any notice of.

Endemicity implies that (1) infection among the natives spreads to some extent; (2) that infected cases, if they do not all die, acquire an immunity, and, further, that that immunity may also be acquired through mild and frequent attacks of the disease in childhood; (3) endemicity and immunity proceed *pari passu*, and in the foci we may have epidemic explosions from time to time.

If yellow fever is always introduced the question is, 'Why does it not spread?' The answer to this may be (1) that there are not sufficient *Stegomyia* over the areas, but here in Lagos the *Stegomyia* is found in almost every house and constitutes the commonest type of mosquito in the place; (2) it may not spread because the endemicity and consequent immunity are much larger than is suspected. Here in Lagos, with its thousands of native inhabitants, living in very close relationship, and in houses in all of which *Stegomyia* can be and has been found (we have had cases from different areas of the town), yet in no case, except among the Europeans and Syrian non-immunes, has more than a single case occurred in the same native house. How can this be explained except by the hypothesis that immunity does exist among the natives, and that that immunity has been acquired through yellow fever being endemic in this country?

This epidemic has demonstrated the fact that the disease is not so virulent in the native as to cause him to seek medical advice, and it is only when a non-immune has contracted the disease with all its typical symptoms, and surveillance is established, that the native cases come to light. Among the native cases in this outbreak, five were Government officials, and it is owing to the fact that they had to report themselves if sick that they were found to be suffering from the disease.

In this epidemic there were no deaths among the natives, while among the non-immunes the death rate was very high. This can only be explained by the fact that the native has an immunity, and that this immunity has been conferred on him by previous mild attacks of this disease, which has been endemic in the country.

An interesting point in connexion with this outbreak is that the disease did not spread to any extent among the European and Syrian residents of Lagos, and this may be accounted for by the following:—

1. That most of the European and Syrian residents, particularly of the mercantile community, have been in West Africa for a long period and have possibly had mild attacks of the disease, which has not been recognized, or else treated as malaria; that this can occur is shown by the fact that in the recent epidemic Case No. 7 died of a virulent type of yellow fever, while Case No. 14, who resided in the same quarters, only had a mild attack and recovered.
2. That all the Europeans and the greater part of the Syrians use mosquito nets at night, and in the case of the Government officials, among whom no cases of the disease occurred, the quarters occupied by them are mosquito-proofed as well.

Excluding the first case, which was really an imported one from Abeokuta, and a typical example of yellow fever in a non-immune, the other five cases reported by me were cases of a mild type of the disease that were followed later by the typical cases of the epidemic which occurred later in July and the following months, thus suggesting that the virus was gaining in intensity through one or more non-immunes who possibly did not seek treatment, and that finally a non-immune developed the disease in its typical and virulent form, as is shown in this epidemic.

With regard to the question as to whether the infection has been brought overland from neighbouring Colonies, the enquiries made by Dr. Wyler in his tour along the French boundary and the results are shown in his report. There is no doubt that yellow fever existed at Abeokuta, as other cases were reported later from that town and dealt with in Dr. Wyler's report. The possibility of the infection having been carried to Abeokuta and other inland towns

from Lagos on the coast must also be admitted, as there is considerable passenger traffic daily from Lagos, and it is quite easy fo mild cases of the disease to travel to the inland towns, where the *Stegomyia* mosquito is one of the commonest varieties.

In these outbreaks the recently-arrived Syrians were attacked, while the disease did not show itself among those who had been resident in Lagos for some years and who had acquired an immunity possibly by mild attacks of the disease for which treatment had not been sought.

With regard to the ship infections, the majority are and have been contracted outside Lagos in other ports of the Colony, viz. at Forcados, Oil Rivers or Calabar.

Appendix B

Among the natives of Calabar, the Cross River districts, and in the Oil Rivers at Bonny, Degema, etc., there is a disease amongst adults, as well as children, which is characterized by a pyrexia of some days' duration, followed by jaundice, which is chiefly seen in the sclerae, and which is known by the name of 'uto enyen,' meaning 'yellow eyes,' or yellow fever.

While in Calabar, I had the opportunity of seeing several of these cases, both in adults and in children, and the jaundice which appeared some days after the commencement of the disease was well marked. Blood examination in nearly all the cases showed the presence of malaria parasites, but, as it has now been proved in the recent epidemics that both infections may and do co-exist in the same individual, and as malaria parasites are known to be harboured by native children, it is quite possible that this disease is a form of mild yellow fever.

It is a matter of great difficulty to obtain statistics with regard to the occurrence of fevers among natives, and the death rate, except in the very large towns where registration of deaths is carried out. Natives do not as a rule seek treatment for mild attacks of fever, and in the recent outbreaks it was only due to the surveillance of the inhabitants of the declared areas that many of the cases came to light.

The chief symptoms of this 'yellow eyes' that I have noted are as follows:—

1. Sudden onset with chills or rigors.
2. Headache and vertigo.
3. Severe vomiting of a bilious character.
4. Loss of appetite.
5. Constipation.
6. Very high coloured urine.
7. Appearance of jaundice, especially marked in the sclerae.
8. General debility and slow convalescence.

Appendix C

In many of the cases quoted in this report it will be remarked that the presence of malaria parasites in the blood was demonstrated, as well as the presence of pigmented leucocytes. In spite of this evidence of active malaria, the cases were diagnosed as yellow fever, complicated with malaria, from the clinical symptoms presented by the cases themselves. It is a well-known fact in the tropics that the malaria parasite can be demonstrated to be present in the blood of cases, especially natives, that are admitted for treatment for some other disease.

The following facts may be of interest:

1. All these cases of yellow fever were admitted and treated in the Lagos hospital, and in two cases in which death had occurred before admission the post-mortem examinations were made at the hospital. The last four cases on the tabular statement were not Lagos cases, so that thirty-two cases were under observation daily from their admission to the day of their discharge, and daily examinations of the blood were made both at the hospital and at the Research Institute.

2. During the year 1913 the following cases of pyrexia were admitted and treated and the cause diagnosed:

(*a*) Cerebro-spinal fever, 1 native.
(*b*) Malarial fever (aestivo-autumnal), 207 natives, 128 Europeans.
(*c*) Pneumonia, 41 natives.

(*d*) Septicaemia, 6 natives.

(*e*) Syphilis, 6 natives, 5 Europeans.

(*f*) Tetanus, 31 natives.

(*g*) Tuberculosis, 17 natives.

(*h*) Yellow fever, 3 Syrians, 20 natives, 9 Europeans.

(*i*) Observation cases with temperature sent in from the declared areas, in which no parasites were found, 84 natives.

(*j*) Pappataci fever, 1 native, 2 Europeans.

The total number was, Syrians 3, Europeans 144, natives 414.

If dysentery and hepatitis are included, the totals would be Syrians 3, Europeans 156, natives 457.

3. In the list of cases quoted in paragraph 2, blood examinations had also been made, and the malaria parasite was found to be present in:

(*a*) Malarial fever, Europeans 128, natives 207.

(*b*) Yellow fever, parasites present in Europeans 3, natives 10; pigmented leucocytes in 11 cases.

(*c*) Pneumonia, 6 cases out of the 41.

(*d*) Tuberculosis, 3 cases out of the 17.

(*e*) Dysentery and hepatitis, 5 out of the 47.

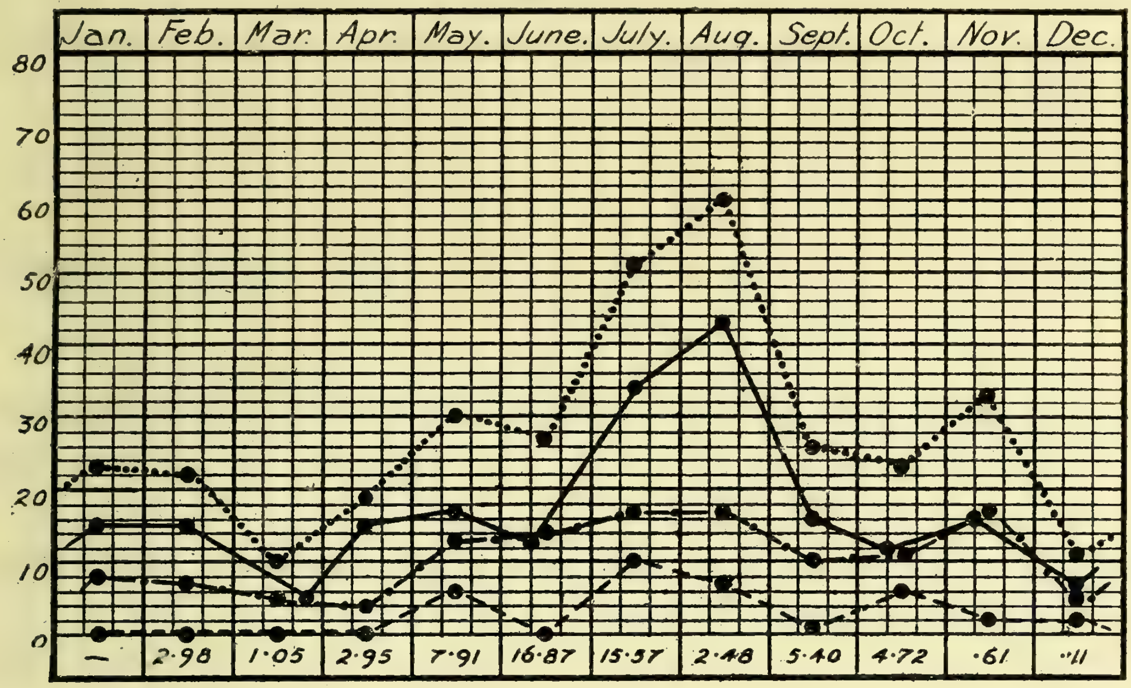
Hence, out of a total number of 616 cases of fever, 362 cases were found to show the presence of the malaria parasite. There were three cases of blackwater fever during the year, and in all three cases the malaria parasite was present.

4. Dr. W. H. G. H. Best, from blood examinations made by himself, found that the proportion of adults with malaria parasites present in their blood, not suffering from fever, was 1 per cent., and in children it was found to be 50·2 per cent.

5. I attach a chart showing the seasonal incidence of malaria fever; this has been worked out from the cases that were admitted into the Lagos hospital for treatment during the year 1913.

CHART

Showing the Seasonal and Monthly Incidence of Malaria Fever and Yellow Fever Cases Admitted into the Hospital at Lagos During the Year 1913.



Total of all Malaria Cases .... *European Cases* —.—.—.
Native Cases ———— *Yellow Fever* - - - - - - -

Appendix D

In this appendix I include reports of the cases of yellow fever that occurred in the months of January and February, 1914, thus completing the report on the various outbreaks in Nigeria of yellow fever for the years 1913 and 1914.

The first case occurred on board the s.s. 'Arnfried' at Warri, and was one of yellow fever; four other cases of fever occurred at the same time, but they were only doubtful.

The next case was reported from Onitsha, a death having occurred in a European who had been ill at Ogouta and was being sent to the hospital at Onitsha.

The next two cases were cases of yellow fever that had occurred at Lagos in February, one being an engineer of one of the vessels lying at Iddo wharf, in Lagos, and the other an assistant in a

trading firm. In 1913, Case No. 18 had occurred at this factory on the 10th August, and was treated at the Lagos hospital.

Lagos was put into quarantine on the occurrence of the second case, and the area was declared infected and all the inhabitants were put under surveillance, the inmates of the infected house itself being sent to the Isolation Hospital for observation. All the houses in the infected area were fumigated. No further cases have occurred up to date.

Report on Five Cases of Fever, by Dr. Booth, Medical Officer, Warri

These cases of fever, one of which is diagnosed as yellow fever, Nos. 2 and 3 as suspicious, 4 and 5 as malarial, occurred on the s.s. 'Arnfried' at Koko.

The first man to fall ill was an engineer, and the other cases were taken ill within twelve hours.

There had been no sickness on board since the vessel left Europe on the 15th November.

On her voyage the vessel had called at Liberia, the Gold Coast, Lagos, Forcados, Warri, Koko, Sapele, and back to Koko, where the men were taken ill.

Case No. 1

European, age 30 years, fireman.

January 6th.—On admission, temperature was 105°, pulse 104, eyes bright with slight injection, headache severe, face flushed, tongue furred on dorsum, red at edges, no jaundice, spleen not enlarged.

Blood examination.—No parasites found.

Urine.—Very thick cloud of albumen present. On the 7th and 8th the amount was the same, on the 9th none was present, but it reappeared on the 10th.

On the day of admission, patient vomited about 4 ounces of brownish material, mostly bile. There was a history of previous vomiting. Food was withheld; no more vomiting occurred, but a certain amount of retching was present. The same amount of quinine was given on the first day as to the others, but not with the same result. Up to January 9th patient complained of severe frontal and occipital headache and pains behind the eyes. The tongue cleared dorsally but remained very red at the tip and edges and was distinctly pointed. On the 8th and 9th January, the stool contained a quantity of bile. The third day after admission temperature went up to 103°, pulse remained slow. Twenty grains of quinine had been given on

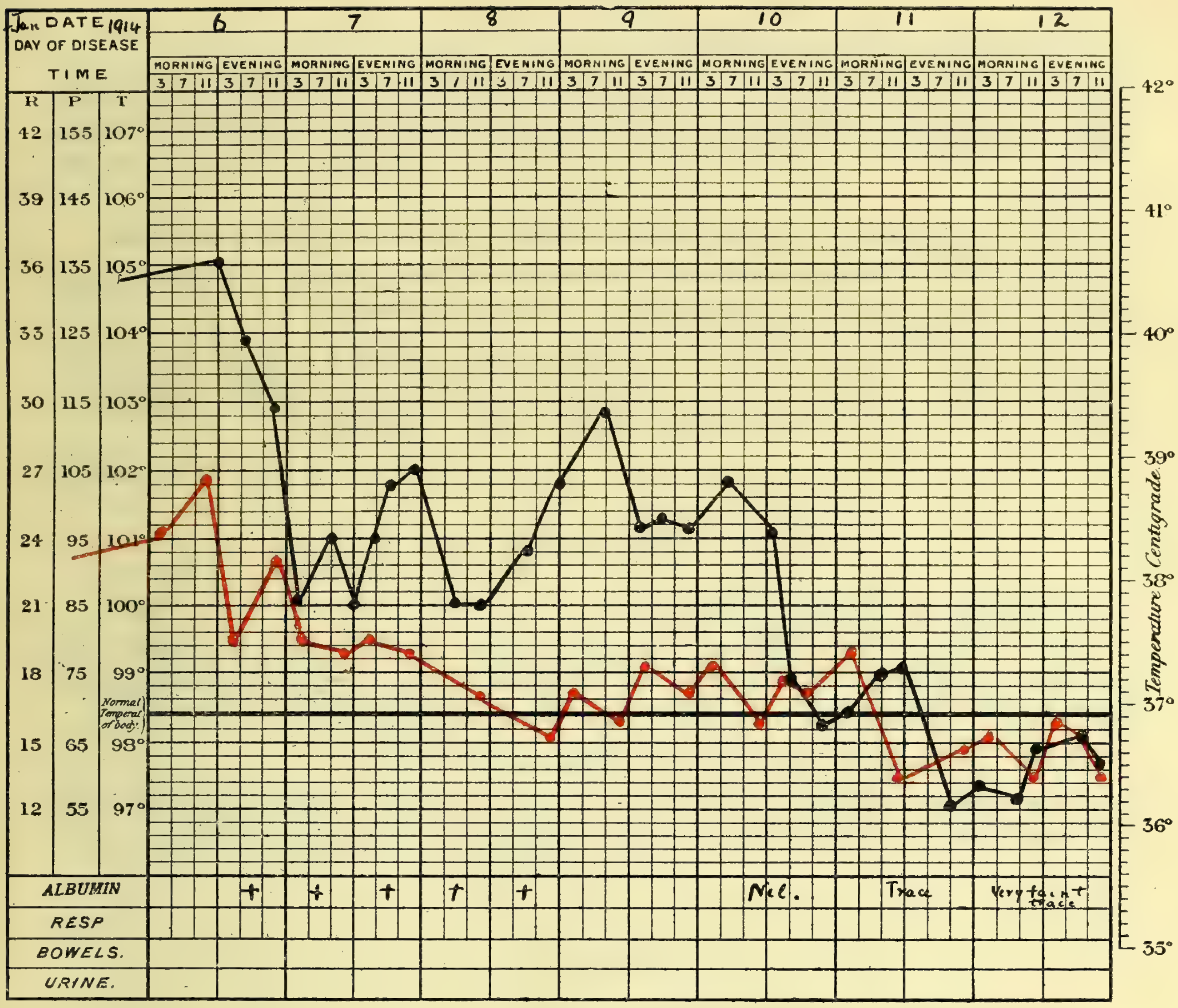


Chart 36

each of the first two days after admission. During the 8th and 9th January (the fifth and sixth days of illness) the pulse rate kept down between 60 and 70 per minute, in spite of the temperature going up. In the other cases the pulse varied according to temperature.

Case No. 2

European, age 23 years, fireman.

6th January.—On admission temperature was 104·6°, pulse 104, eyes bright, slight injection of conjunctivae, very drowsy, headache slight, tongue furred on dorsum, somewhat flabby, red at edges, no jaundice, spleen not palpable.

Blood examination.—Few young rings (subtertian) found, scanty infection.

Urine.—On admission, albumen nil. On the following day a distinct cloud present, also day after. On 9th January, nil.

Stool.—Small quantity of bile in liquid motion.

Case No. 3

European, engineer, age 33 years.

6th January.—On admission temperature was 104·4°, pulse 120, eyes bright, slight injection of conjunctivae, very lethargic, no headache, face slightly suffused, tongue furred, clean at edges and pointed, not flabby, no jaundice, spleen not palpable.

Blood examination.—Young rings (subtertian) found, fairly heavy infection.

Urine.—None was obtained until late on the following day, 10 ozs. only passed. Slight albumen present and persisted until the 11th January.

On the evening of the day of admission patient vomited a small quantity of greenish fluid; some hours later vomiting occurred again, similar quantity of greenish fluid. Rise of temperature occurred again third day.

Case No. 4

European, age 23 years, engineer.

6th January.—On admission temperature was 103·2°, pulse 100, skin dry, headache very slight, eyes bright, no injection, tongue furred and flabby, no jaundice, spleen enlarged, edge felt below the costal margin.

Blood examination.—Young rings (subtertian) numerous.

Urine.—Very slight trace of albumen on admission, hardly noticeable next day, and disappearing after that. Patient responded to quinine at once.

Case No. 5

European, age 36 years, boatswain.

On admission temperature was 103·4°, pulse 128, no injection of eyes, somewhat drowsy, slight headache, tongue foul and flabby, no jaundice, spleen not palpable, area of dullness increased.

Blood examination.—Young rings (subtertian) numerous.

Urine.—Slight trace of albumen, which persisted until the 9th January.

From the above report, Case No. 1, in my opinion, is undoubtedly a mild infection of yellow fever. In Cases 2 and 3, although malaria parasites were found to be present, the signs and symptoms as a whole do not present a picture of a simple malarial infection, and should be regarded as distinctly suspicious. In Cases Nos. 4 and 5, there is very little doubt of their being ordinary cases of subtertian malarial fever. The reports are very meagre of details. Faget's sign is undoubtedly present in Case No. 1, and to a less extent in Cases 2 and 3, while absent in Cases 4 and 5.

Report of a Case from Dr. Tipper, Onitsha

The body of a European was brought into Onitsha at 11.30 p.m. on the 13th January, death having occurred shortly before, outside Onitsha, at Newi. A letter that accompanied the deceased stated that he had been suffering from 'bilious fever' for some days previously, and had been treated by the Medical Officer at Ogouta, and that quinine had been used.

Autopsy was performed 16 hours after death.

Skin.—Universally bright yellow in colour. Conjunctivae showing haemorrhagic injection at lower and outer corneo-sclerotic junction. Sclerae bright yellow. Undue post-mortem staining of the right arm and dependent parts of the back and legs. There was some dark red blood streaming from the angle of the mouth which had obviously been vomited.

Stomach.—A bluish-black, semi-coagulated mucus covered the surface of the interior. Here and there was seen very dark coloured blood, similar to that found issuing from the mouth. The mucous membrane was of a black colour but mottled, the black portions alternating with the red patches. The rugae were easily broken. The peritoneal surface was almost black, but dull red patches and ecchymoses occurred here and there.

Liver.—A bright yellow ochre colour. The anterior parts of the under surfaces of the right and left lobes were black. On section, bright yellow. The substance of the organ was soft and friable and flabby in the extreme.

Lungs.—These were universally black, soft and friable. On the lower lobe of the left lung there was a large patch of blood extravasation into the pleura. No pneumonic or other consolidation present. Sections floated in water.

Intestines.—Dirty yellowish white in colour. Peritoneal surface showed subperitoneal haemorrhages. Mucous membrane had a bruised appearance due to the blood within the interstices of the tissues.

Heart.—The whole organ was flabby, fat was bright yellow in colour. Muscular fibres were deep red in colour. Valves were normal.

Spleen.—Slightly enlarged, softer than normal.

Kidneys.—Slightly enlarged, pale yellowish infiltration of the cortex.

Bladder.—Empty, normal.

Brain.—Congested, ventricles contained fluid of a light lemon colour.

Specimens were sent to the Research Institute, Yaba.

Laboratory Report

Spleen.—Congested, some black pigment present.

Brain.—Congested, round-celled infiltration present.

Liver.—Advanced necrotic changes, fatty degeneration present.

Kidney.—Epithelium of convoluted tubules necrosed and desquamated in parts; elsewhere showing cloudy swelling and marked fatty changes. Glomerular tufts swollen and congested. Lumen of tubules mostly blocked by desquamated cells and débris.

Previous history of the case.—The deceased was employed on a survey of the Engenni River, and had gone up the river from Degema. He left the vessel at Akara Queri on the 2nd January, and proceeded to Ogouta, where he arrived on the 6th. He got ill at Ogouta, and suffered from fever with vomiting. On the 9th he was seen by the Medical Officer, Owerri, who apparently formed the opinion that he was suffering from 'bilious remittent fever.' The Medical Officer was called away on the 10th, and on the 13th the patient seemed to have

become delirious and was sent off in a hammock by the Agent at Ogouta to Onitsha hospital, but patient died shortly before arriving there.

The infection in this case was contracted at some point between Degema and Ogouta, possibly on the ship itself or at some native town where the deceased had stayed on the way up to Ogouta. No blood examination records, or any notes or temperature chart of the case are available.

Note by Commission

Pathological material from this case was examined by Dr. A. C. Stevenson, of the Wellcome Bureau of Scientific Research, who made the following report:—

Liver.—Fairly advanced cirrhosis—lobules practically indistinguishable—areas of fatty degeneration. Other areas, larger, show well-marked necrosis, some, no doubt, due to post-mortem change. No signs of acidophilic change. Pigment, malarial in appearance; soluble in acid alcohol.

Kidney.—Advanced cirrhotic change; thickened capsule with fibrous tissue spreading from it between the tubules. Marked thickening of Bowman's capsule. Cloudy swelling of convoluted tubules towards the surface of the kidney. Straight tubules full of desquamated epithelial cells. In some parts of intermediate zone complete necrosis (? partly post-mortem). Desquamation in tubules of papillary region. Concretions in some tubules. Pigment, malarial in appearance, in Malpighian tufts; soluble in acid alcohol.

Spleen.—Congested, excess of small round cells. Some fibrous increase and thickening of vessel walls. Malaria-like pigment.

Brain.—? softening—many round spaces in some of which are bacteria which are also seen in blood vessels (? post-mortem). A fair number of concretions (psammomata). Capillaries mostly empty—small vessels engorged. In the endothelial cells of the capillaries small quantities of malaria-like pigment are seen.

Remarks.—No definite signs of yellow fever, but those of advanced alcoholism.

Case No. 1.—Lagos. L. 121

Age: 30 years.
Sex: Male.
Nationality: European, British.
Occupation: Engineer.
Date of admission: 12th February, 1914.
Date of discharge: 27th February, 1914.
Diagnosis: Yellow fever.

History.—Patient states that he first felt ill on the 9th February, with rigors followed by severe frontal headache and fever. There was no vomiting, but nausea was present. Patient took quinine that night and also next day, but felt no better. On the 11th, he again had rigors and a high temperature, accompanied by severe frontal headache and aching pains in the extremities. This morning he was seen by Dr. Maples, and as his temperature was 104°, he was sent to the hospital. Patient has only been out five months and this is his first tour on the Coast. He has taken quinine regularly.

On admission.—Patient complained of very severe frontal headache and pains in the eyes. Conjunctivae were red and injected. Eyes shining. Temperature was 104·2°, pulse rate 88 per minute.

Alimentary system.—Tongue was furred, with clean red tip and edges. Bowels were constipated. Gums red and swollen. Nausea and epigastric discomfort present, increasing on pressure. Patient had no vomiting, but severe retching had been present on the day before admission. Liver and spleen were both normal in size, with no tenderness on palpation.

Circulatory system.—Heart sounds were normal. Pulse, 88 per minute.

Respiratory system.—Lungs were normal. Respirations were hurried, 36 per minute.

Nervous system.—Severe frontal headache and pains in the eyes. Aching pains in the extremities. Reflexes were normal.

Urinary system.—Patient stated that the urine was diminished in quantity and high coloured. On examination: Acid reaction. Sp. gr. 1010. Albumen present.

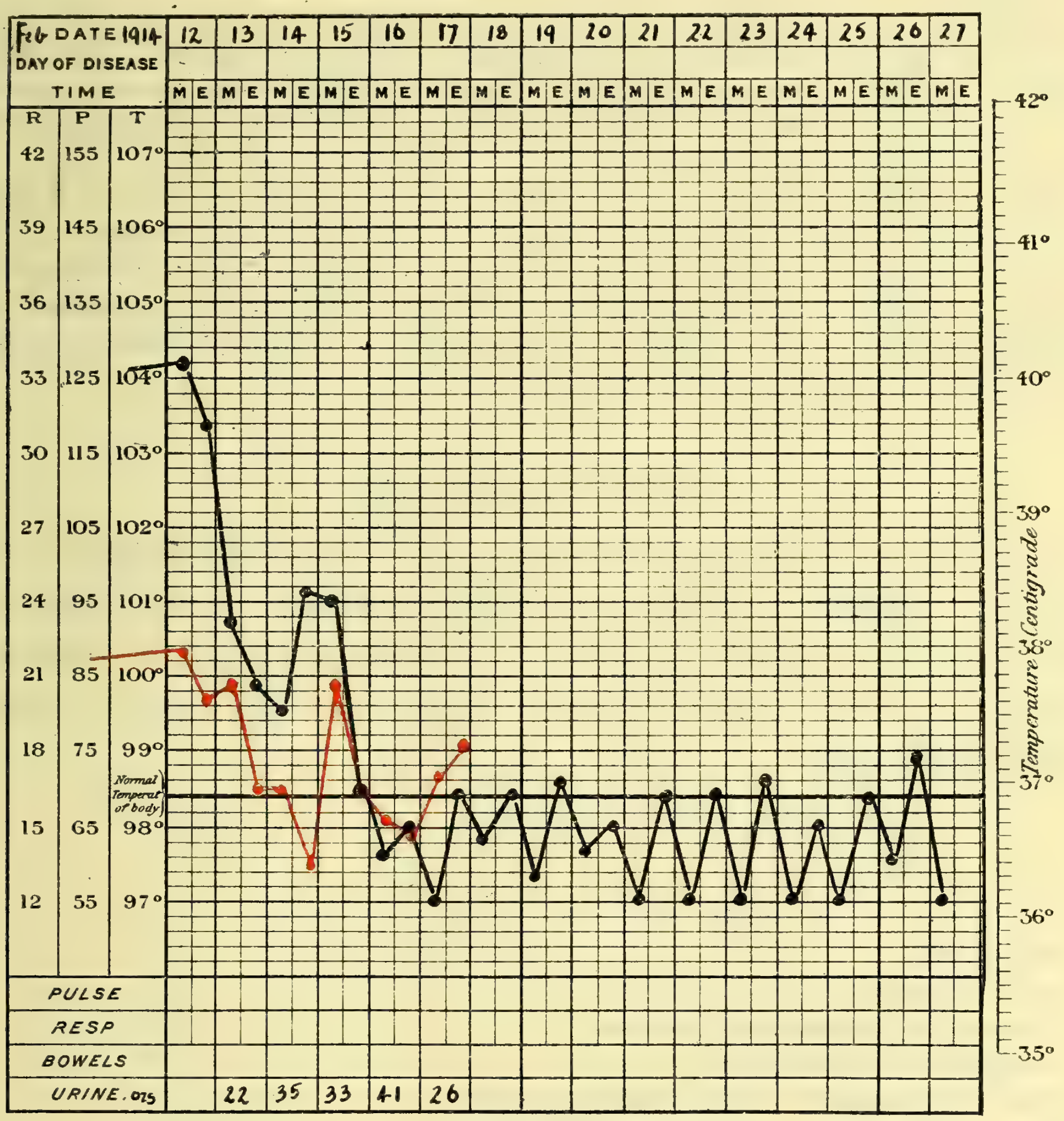


Chart 37

Blood examination.—Few young ring forms of subtertian malaria present. *Paraplasma flavigenum* present. Differential count: Polymorphonuclear, 72·6 per cent.; lymphocytes, 17·2 per cent.; mononuclear, 8·4 per cent.; transitionals, 1·8 per cent.

9 p.m. Patient passed 10 ozs. of urine, none having been passed during the day. Nausea and retching were troublesome. No vomiting. Bowels were opened after calomel. Temperature 103·6°, pulse rate 80.

13*th February*.—Patient had a restless night and only slept after a draught. Bowels were opened twice in the morning. Urine was passed, 22 ozs., and on examination was acid in reaction, sp. gr. 1022. Albumen had increased in amount. Temperature at 8 a.m. was 100·8°, pulse 84. Nausea and epigastric discomfort still present. Sclerae are tinged with yellow. Headache and muscular pains still persist. Temperature at 8 p.m. was 99·8°, pulse rate 64.

14*th February*.—Patient had a better night and feels better this morning. Nausea and epigastric discomfort still present, but much lessened. Bowels were opened. Urine passed in increased quantity. On examination : Acid in reaction. Sp. gr. 1025. Albumen present. Sclerae yellow. Temperature at 8 a.m. was 99·4°, pulse 70. At 8 p.m. it was 101·2°, pulse rate 60.

15*th February*.—Patient had a restless night, temperature rose to 102·4°, pulse rate 88 per minute. At 8 a.m. temperature was 101°, pulse 84. Nausea still present. Jaundice now well marked. Urine still diminished, 33 ozs. passed in the twenty-four hours, and contains albumen. Bowels opened twice. Temperature at 8 p.m. 98·4°, pulse 72.

16*th February*.—Patient had a good night. Appetite returned. Jaundice more marked. Urine is acid in reaction. Sp. gr. 1022. No albumen present. Temperature subnormal, pulse rate 64. Bowels opened. Patient continued to progress favourably. Appetite returned. Bowels regular. Urine returned to its normal quantity. Jaundice gradually disappeared on the 21st February, and the patient was discharged cured on the 27th February.

Note by Commission

Some blood films from this case were examined by Dr. C. M. Wenyon, Director of Research in the Tropics to the Wellcome Bureau of Scientific Research, who found them to contain subtertian malaria parasites, some of which were small and had a curious compact structure.

Case No. 2.—Lagos. L. 122

Sex : Male.
Age : 27 years.
Nationality : European, German.
Occupation : Trader.
Date of admission : 14th February, 1914.
Date of discharge : 27th February, 1914.
Diagnosis : Yellow fever.

History.—Patient states that he felt ill yesterday, the 13th, in the morning, with chills and frontal headache. Became gradually worse during the day, and at night his temperature was 104°, with very severe headache and pains in the extremities. He was seen by his medical attendant, Dr. Maples, who gave him an intramuscular injection of quinine. He had a bad night, but felt better early next morning.

During the day the temperature again rose, headache became severe, nausea and epigastric discomfort was present. No vomiting until he made himself vomit to relieve the nausea. In the evening his temperature was 104°, conjunctivae were injected and red, headache very severe, and his urine on examination was albuminous. So he was sent to the hospital at 7 p.m.

On admission.—Temperature was 101·8°, pulse rate 98. Conjunctivae very injected. Complained of severe frontal headache and aching pains in the loins. Patient has only been out eight months of this, his first, tour. Has taken quinine regularly.

Alimentary system.—Gums red and swollen. Tongue, white dorsum, with red tip and edges. Bowels constipated. Liver and spleen both normal, no tenderness. Nausea and epigastric discomfort present. Great thirst present.

Circulatory system.—Heart sounds normal. Pulse slow, 90 at 8 p.m.

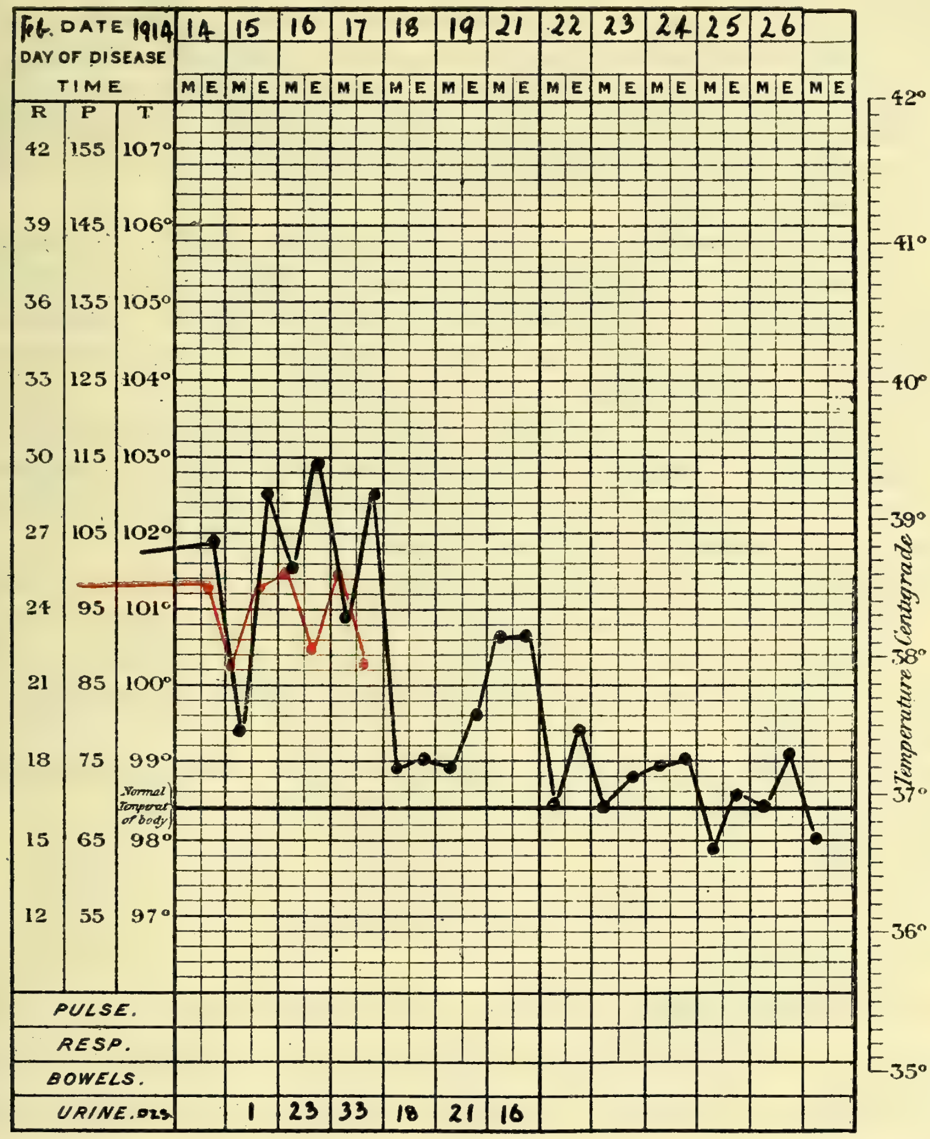


Chart 38

Respiratory system.—Lungs normal. Respirations hurried.

Nervous system.—Severe frontal headache present. Aching pains in the loins. Reflexes normal.

Urinary system.—Urine passed on admission. Very high coloured. Acid reaction. Sp. gr. 1030. Albumen present, high percentage. Quantity has been diminished.

Other systems.—Skin, sweating. Face very flushed. Conjunctivae injected. Eyes shining. Photophobia present.

Blood examination.—No malaria parasites present. *Paraplasma flavigenum* present. Differential count: Polymorphonuclears, 61 per cent.; lymphocytes, 27·4 per cent.; mononuclear, 8·4 per cent.; transitionals, 2·8 per cent.; mast cells, 0·4 per cent.

15*th February.*—Patient had a fair night, but was restless in the early part. Bowels moved after calomel. Urine passed but diminished in quantity, only 7 ozs. passed in the previous twenty-four hours. Highly albuminous. Temperature at 8 a.m. was 99·4°, pulse rate 88. Tube casts present in the urine. During the day the temperature rose, and at 4 p.m. was 103·6°, pulse 100. Patient very excitable, complained of great thirst. Face very flushed and conjunctivae were very injected. At 8 p.m. temperature was 102·4°, pulse 96.

16*th February.*—Patient was very restless last night and only slept after a draught. Conjunctivae very injected. Nausea troublesome. Urine still diminished and contains albumen. Patient is very nervous and complains of great thirst. Temperature at 8 a.m. was 101·6°, pulse rate 88. At 8 p.m. temperature rose to 102·8°, pulse rate 90.

17*th February.*—Patient had a better night and slept. Is feeling much improved this morning. Temperature at 8 a.m. 100·6°, pulse 100. Headache still present, also loin pains. Urine is still diminished and contains albumen, sp. gr. 1030, acid reaction. At 8 p.m. temperature rose to 102·4°, with pulse of 90. Thirst is lessened. Conjunctivae still injected.

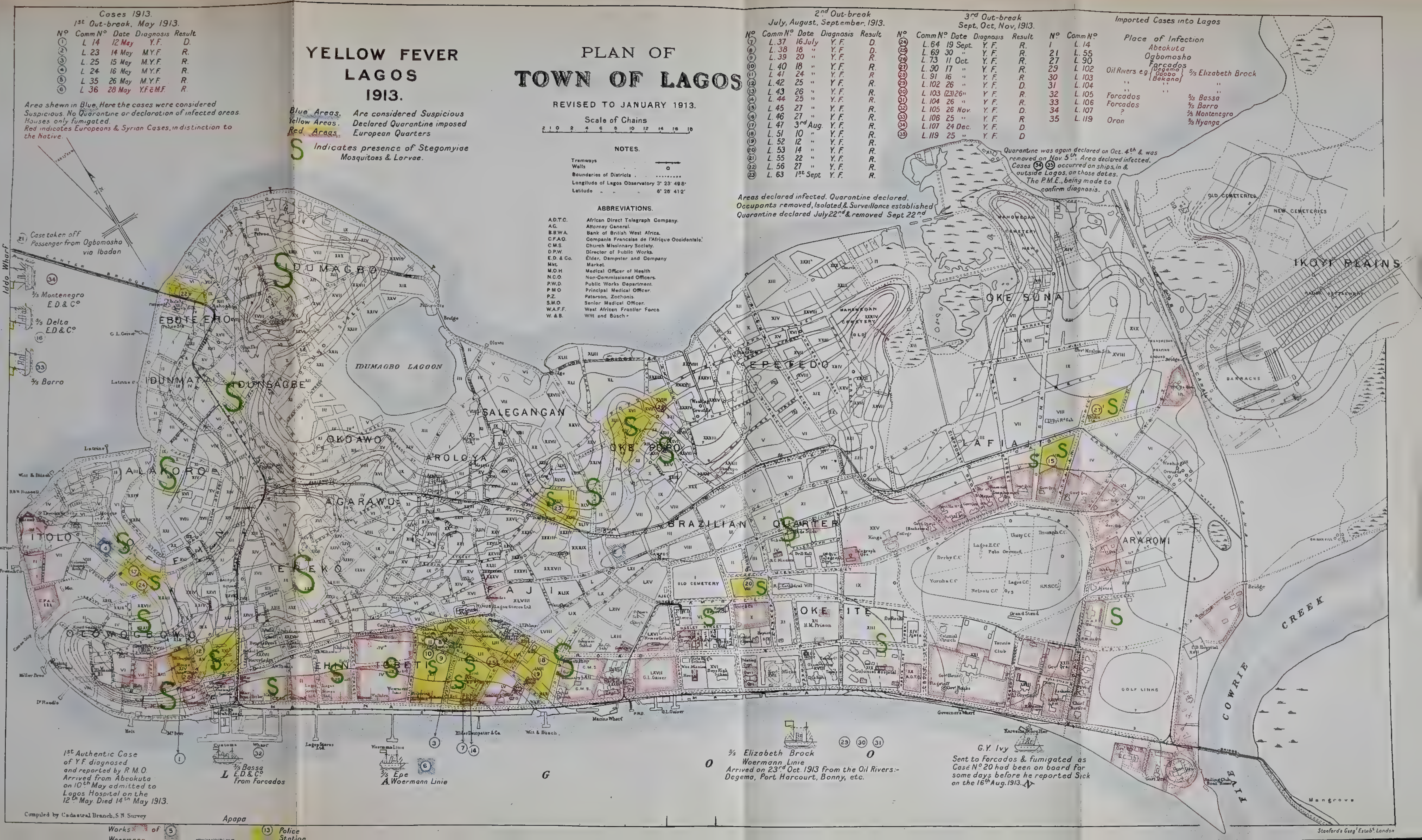
18*th February.*—Patient had a good night and is feeling very much better. Bowels opened. Urine passed in increased quantity, and on examination still contains albumen. Conjunctival injection passing off. Sclerae are now tinged with yellow. Temperature is 99°, with pulse rate of 100.

19*th February.*—Patient is much improved and had a good night. Temperature still 99°. Bowels opened. Urine examined and found to contain bile, but no albumen. Sclerae are decidedly yellow. Nausea and epigastric discomfort have passed off. Appetite is returning. Urine has not yet reached the normal. Headache quite gone.

Patient continued to improve gradually, jaundice slowly disappeared on the 24th, and patient was discharged cured on the 27th February.

Note by Commission

Some blood films from this case were examined by Dr. Wenyon, who found red cells with patches of basophilic change. In one film curious star-like artefacts occurred which he thought might be mistaken for parasites.



YELLOW FEVER
LAGOS
1913.
PLAN OF
TOWN OF LAGOS
REVISED TO JANUARY 1913.
Scale of Chains
Cases 1913.
1st Out-break, May 1913.
Nº Comm Nº Date Diagnosis Result
1 L 14 12 May Y.F. D.
2 L. 23 14 May M.Y.F. R.
3 L. 25 15 May M.Y.F. R.
4 L 24 16 May M.Y.F. R.
5 L. 35 26 May M.Y.F. R.
6 L 36 28 May Y.F. c̄ M.F. R.
Area shewn in Blue. Here the cases were considered Suspicious. No Quarantine or declaration of infected areas. Houses only fumigated.
Red indicates Europeans & Syrian Cases, in distinction to the Native.
Blue Areas. Are considered Suspicious
Yellow Areas. Declared Quarantine imposed
Red Areas. European Quarters
S Indicates presence of Stegomyiae Mosquitoes & Larvae.
2nd Out-break
July, August, September, 1913.
Nº Comm Nº Date Diagnosis Result
7 L. 37 16 July Y.F. D.
8 L. 38 18 " Y.F. D.
9 L. 39 20 " Y.F. R.
10 L. 40 18 " Y.F. R.
11 L. 41 24 " Y.F. R.
12 L. 42 25 " Y.F. R.
13 L. 43 26 " Y.F. R.
14 L. 44 25 " Y.F. R.
15 L. 45 27 " Y.F. R.
16 L. 46 27 " Y.F. R.
17 L. 47 3rd Aug. Y.F. R.
18 L. 51 10 " Y.F. R.
19 L. 52 12 " Y.F. R.
20 L. 53 14 " Y.F. R.
21 L. 55 22 " Y.F. R.
22 L. 56 27 " Y.F. R.
23 L. 63 1st Sept Y.F. R.
3rd Out-break
Sept, Oct, Nov, 1913.
Nº Comm Nº Date Diagnosis Result
24 L. 64 19 Sept. Y.F. R.
25 L. 69 30 " Y.F. R.
26 L. 73 11 Oct. Y.F. R.
27 L. 90 17 " Y.F. R.
28 L. 91 16 " Y.F. R.
29 L. 102 26 " Y.F. D.
30 L. 103 (23)26" Y.F. R.
31 L. 104 26 " Y.F. R.
32 L. 105 26 Nov. Y.F. D.
33 L. 106 25 " Y.F. R.
34 L. 107 24 Dec. Y.F. D.
35 L. 119 25 " Y.F. D
Imported Cases into Lagos
Nº Comm Nº Place of Infection
1 L. 14 Abeokuta
21 L. 55 Ogbomosho
27 L. 90 Forcados
29 L. 102 Oil Rivers e.g. {Degema, Opobo, Bakana} S/s Elizabeth Brock
30 L. 103 " " "
31 L. 104 " " "
32 L. 105 Forcados S/s Bassa
33 L. 106 Forcados S/s Barro
34 L. 107 ? S/s Montenegro
35 L. 119 Oron S/s Nyanga
Areas declared infected. Quarantine declared. Occupants removed, Isolated, & Surveillance established. Quarantine declared July 22nd & removed Sept 22nd
Quarantine was again declared on Oct. 4th & was removed on Nov 5th. Area declared infected. Cases 34 35 occurred on ships, in & outside Lagos, on those dates. The P.M.E., being made to confirm diagnosis.
NOTES.
Tramways
Wells
Boundaries of Districts
Longitude of Lagos Observatory 3° 23' 48.8"
Latitude 6° 26' 41.2"
ABBREVIATIONS.
A.D.T.C. African Direct Telegraph Company.
A.G. Attorney General.
B.B.W.A. Bank of British West Africa.
C.F.A.O. Compagnie Francaise de l'Afrique Occidentale.
C.M.S. Church Missionary Society.
D.P.W. Director of Public Works.
E.D. & Co. Elder, Dempster and Company
Mkt. Market.
M.O.H. Medical Officer of Health
N.C.O. Non-Commissioned Officers.
P.W.D. Public Works Department.
P.M.O. Principal Medical Officer.
P.Z. Paterson, Zochonis.
S.M.O. Senior Medical Officer.
W.A.F.F. West African Frontier Force
W. & B. Witt and Busch.
21 Caretaker off Passenger from Ogbomosho via Ibadan
Iddo Wharf
34 S/s Montenegro E.D. & Cº
S/s Delta E.D. & Cº
33 S/s Barro
IDUMAGBO
EBUTE ERO
IDUMAGBO LAGOON
IDUNMATA
IDUNSAGBE
SALEGANGAN
OKOAWO
AROLOYA
OKE POPO
EPETEDO
OKE SUNA
IKOYI PLAINS
OLD CEMETERIES
NEW CEMETERIES
ALAKORO
AGARAWU
AFIA
BRAZILIAN QUARTER
ITOLO
EREKO
FAJI
ARAROMI
OKE ITE
OLOWOGBOWO
EHIN
ISSETI
OLD CEMETERY
BARRACKS
GOLF LINKS
COWRIE CREEK
1st Authentic Case of Y.F diagnosed and reported by R.M.O. Arrived from Abeokuta on 10th May admitted to Lagos Hospital on the 12th May Died 14th May 1913.
32 S/s Bassa E.D. & Cº From Forcados
S/s Epe Woermann Linie
S/s Elizabeth Brock Woermann Linie Arrived on 23rd Oct. 1913 from the Oil Rivers:- Degema, Port Harcourt, Bonny, etc.
G.Y. Ivy Sent to Forcados & fumigated as Case Nº 20 had been on board for some days before he reported Sick on the 16th Aug. 1913.
LAGOS HARBOUR
Compiled by Cadastral Branch, S.N. Survey
Stanford's Geog! Estab! London
Apapa

REPORT ON A VISIT TO GUAYAQUIL

BY

J. M. O'BRIEN, M.R.C.S. (Eng.), L.R.C.P. (Lond.), D.T.M. and H (Cantab.), *Medical Officer, West African Medical Staff*.

Sailing from London on the 8th October, I arrived at Guayaquil, Ecuador, on the 31st of that month.

Mr. Cartwright, British Consul there, kindly introduced me to Dr. Becerra, the Director de Sanidad, and through the latter I met the medical men in charge of the departments which were of interest to me.

Those which I selected for most attention were: The Yellow Fever Lazareto, the children's wards in the Asilo Mann, and the Sala de Observación in the Hospital General. In this hospital there is no out-patient department, but patients come at all hours of the day, and wait on the beds of the ward for the twice-daily visit of the doctor. All cases which might in any way be suspected of being yellow fever, plague, or other infectious disease, are detained here until a definite diagnosis can be made. On account of this system, the Sala de Observación lent itself well to the kind of work I proposed to myself, *i.e.*, to attempt to obtain some skill in the diagnosis of yellow fever in mild cases and in the early stage. To this end I included in my study a considerable number of cases which, some sooner and some later, showed clear symptoms of diseases other than yellow fever.

In the children's wards of the Asilo Mann, I was surprised to be unable to find anything resembling yellow fever. I was allowed to examine the books of the hospital, and found in them the rare cases diagnosed, noting the fact that no child under four years had suffered from the disease. To this matter I shall refer later.

In the Lazareto de Fiebre Amarilla, I was able to follow the course of the disease in cases which, as a rule, I saw first in the Sala de Observación.

During the first six weeks of my stay in Guayaquil, the plague lazareto was fairly full and gave me an opportunity of seeing about 150 cases of the disease. Unfortunately, my other work prevented my making a regular daily visit here.

A severe epidemic of dysentery (ascribed to Shiga's bacillus) broke out during the latter part of my sojourn. Of this disease I was also enabled to see a considerable number of cases, especially amongst children. Here it was notable that the fatality amongst boys was much greater than amongst girls. The disease was similar to the amoebic dysentery common in parts of the Gold Coast, but inclined to take a more severe and bloodier form. Statistics anent this outbreak were not to hand when I left.

Sanitary Condition of Guayaquil

The sanitary condition of Guayaquil is especially fitted for the maintenance of yellow fever. There is a partial water supply, *i.e.*, water is supplied to the houses during a few hours of the morning. The consumers draw off what they want and fill their cisterns. These cisterns are rarely properly screened.

Amongst the poorest classes, water is obtained from stand-pipes in the streets, but, again, during the morning only, with the result that small quantities of water are stored in the houses. In this way the *Stegomyia fasciata* finds good breeding-places everywhere at hand. Moreover, owing to the building methods, most rooms are dark, and provide admirable shelter for the mosquito after feeding. The citizens of Guayaquil are immune to yellow fever, and by long use have acquired much insensibility to mosquito bites. They are, therefore, rather careless in these matters. On the other hand, to maintain the disease, there is a continual influx of non-immunes from the mountains—poor people who come looking for work, and who have no idea of protecting themselves.

General Description of Cases

In spite of these favourable conditions, I did not see more than nineteen cases come into hospital. Of the cases that occurred in private practice, I have knowledge of only one—this I saw by courtesy of the physician in charge of the case.

Of the really mild cases, which I wished most to see, there were only two. Probably most such cases occurring in the town recovered at home, either untreated, or treated and diagnosed as malaria.

Those patients that came under my notice were, therefore, suffering from the disease in an advanced or grave form, leaving as a rule no possible doubt as to the diagnosis, and according in

character with the text-book descriptions. Nevertheless, I would like to bring forward some points which, as far as I know, have not been previously mentioned or on which little stress is laid.

A slight abnormality of the heart sounds is common. This was brought to my notice by some local practitioners, and I was enabled to corroborate their observations in several cases. The abnormality consists of an alteration of the first sound, sometimes merely lengthening it, sometimes merely altering its tone, and at other times producing a definite murmur. The murmur may be presystolic, systolic, or post-systolic in time, generally presystolic, and is of a blowing character. It is best heard between the third and fourth costal cartilages, and internal to the nipple line. It appears early in the disease (about the third day), and may disappear at any time subsequently, without reference to the condition of the patient.

Unfortunately, only two post-mortem examinations in cases of yellow fever were performed while I was in Guayaquil. In one of these, the aortic valve showed what appeared to be a penetrating ulcer of one of its cusps, while the tricuspid showed some reddening and thickening. In the second case, the mitral valve showed a slight sub-endocardial haemorrhage on the ventricular surface of one of its flaps.

The former case I saw for the first time the day before death, and no murmur could be made out in the very weak heart beat.

The second had a slight presystolic murmur on the third day of the disease. This disappeared on the fourth day; death occurred on the morning of the sixth.

It is not improbable that sub-endocardial haemorrhages are the usual cause of this symptom.

I have seen some cases which showed that icteric tinging of the eyes and skin could be very slight and transient in well-defined cases of yellow fever. Often it does not become at all marked till about the eighth day.

This point has some importance when the patient has, even in health, yellow conjunctivae, combined with the black skin of the African native. If one is to use the symptom in diagnosis, a sharp observation of the condition of the eye must be made daily, and it should be borne in mind that the absence of observable increase in the icterus does not exclude yellow fever.

The liver is generally painful. In some cases, this pain may be merely an extension of the epigastralgia. In others, however, it extends well round to the side, and occasionally it is limited to particular points.

The spleen is sometimes tender.

In the cases which came under my notice the patients very rarely complained of rachialgia; when they did, it passed off early in the illness. This is noteworthy if one considers that at one time yellow fever was known as 'coup de barre,' and it suggests that, in some epidemics, symptoms disappear which in others have dominated the illness.

An increase in the percentage of albumen in the urine as the temperature drops is one of the classical signs of yellow fever. It is, however, not constant.

Microscopical Examinations of Blood

Differential leucocyte counts present the following points of interest:—

The percentage of polymorphonuclears is nearly always high.

The number of large mononuclears is generally normal.

The lymphocytes sometimes diminish, almost to disappearing point, but on the other hand, in some well-defined cases of yellow fever, maintain their percentage normally high.

Eosinophils are frequently entirely absent, but the same may be said of the blood of natives of Ecuador in other diseases.

The percentage of transitionals varies between the usual limits of my counts.

Mast cells are commonly present.

The differential counts in general suggest an increase in the percentage of polymorphonuclears, rather than a decrease in the other elements.

With regard to the occasional very low percentage of lymphocytes, judging from the small number of slides I have been able to examine, I think that a low lymphocyte count is normal to the people of this country.

As convalescence progresses, the percentages adjust themselves to the normal.

That, however, which calls for most attention in these examina-

tions of stained blood (Giemsa) is the condition of the polymorphonuclears.

From what I have recently seen, I am inclined to think that in a very large proportion of yellow fever cases these cells are acutely degenerated. I think that this degeneration is often so considerable on the fourth day of the disease as to be of diagnostic value. Since I first observed this phenomenon, I have looked for it in some dozen cases of plague, in a few cases each of dysentery, typhoid, malaria, and pregnancy. In all these, some few degenerated polymorphonuclears may be seen, but they are not affected in the wholesale manner which can be seen in yellow fever.

In two other cases of fever, I saw the first stage of the degeneration. A diagnosis of yellow fever could not be made, nor was any other diagnosis—both patients were non-immunes.

In a typical case, about the third day of the fever, some half of the polymorphonuclears lose the brown, stippled, staining reaction which their protoplasm has towards Giemsa; by the fourth day almost all have lost this colouring; only faint dots may be seen in the cytoplasm of some, in others the cytoplasm is obviously unstained and hardly discernible.

The nucleus during this stage remains normal.

In the next stage, the protoplasm edge looks torn and ragged, the nucleus becomes splayed out and lightly stained; without having seen the various stages of the transformation it would be difficult to recognise the cell.

Later, the protoplasm contracts, assumes a rounded form and takes on a light pink colour. The nucleus is rounded and small—its stain becomes intense.

In the most advanced stage observed the nucleus is round with perhaps one or two drop-shaped fragments of nuclear matter near it. The cytoplasm is circular, and about twice the size of a red blood corpuscle. It has a pinkish stain. More than anything else it suggests in shape a small round *Amoeba coli.* This form is sparsely scattered in the slides.

This alteration in these corpuscles, which I consider to be a degeneration largely on account of the loss of staining reaction of the cytoplasm in the first stage, does not always proceed even to the second stage; indeed, occasional leucocytes in the third stage

are more common late in the disease than is the second stage in the middle term. On the other hand, so advanced is the second stage sometimes that it is a matter of surprise that the patient can live with almost every polymorphonuclear leucocyte in such a state of ruin as to be practically unrecognizable. Nevertheless, some of these cases make a quick recovery.

I lay some stress on these observations, as I do not know that they have been previously recorded. Yet, when once noticed, they seem obvious.

In those cases of plague which I examined, the tendency of the polymorphonuclears was to be small, of normal shape, and with the cytoplasm more intensely stippled than usual. In one case of pneumonia, the cytoplasm was large in amount, with coarse, loosely scattered brown granules.

Vacuolation of the polymorphonuclears is common in yellow fever, but not constant. The vacuoles are small and from one to eight in number as a rule. I suggest that they are due to phagocytosis of the blood platelets; their size is in agreement with this suggestion, and phagocytosis of blood platelets may be observed in some cases.

The vacuolation affects the cytoplasm and not the nucleus; it is sometimes responsible for the very tattered appearance of the cells in the second stage of degeneration.

It would be of great interest to ascertain whether those diseases with which mild cases of yellow fever can be easily confounded, *e.g.*, Weil's disease, pappataci fever, three days' fever, six days' fever, seven days' fever, pseudo-dengue, etc., also show any parallel changes in the polymorphonuclears.

Of the parasite demonstrated to me by Dr. Seidelin I have unfortunately seen nothing.

Immunity of Infants and Very Young Children

I have alluded above to the absence of yellow fever amongst young children in Guayaquil. This has been observed in other epidemics.

In the records of the children's wards of the Asilo Mann, I find that in 618 children at the breast admitted between October, 1909, and the end of December, 1913, there were no cases of yellow fever.

From 4th January, 1911, to the end of December, 1913, 1,480 boys were admitted, amongst them 24 cases of yellow fever, the average age being nine and a fraction. One was four years old. Three were five years old. The eldest was fifteen years old (although children over twelve are not usually admitted) and a native of Guyaquil, as was one other of eleven years of age.

2,218 girls were admitted between January, 1907, and the end of December, 1913. Amongst these were 19 cases of yellow fever—a notably lower percentage than that given by the boys, the average age in these nineteen cases being eight and a half years. One was four years old, and two were five years old. Three were born in Guayaquil, and were respectively five, six, and seven years of age when attacked with yellow fever.

I have spoken on this subject to many medical men in Guayaquil.

These practitioners are as well acquainted with yellow fever as ours of London are with broncho-pneumonia or measles, yet they are unanimous in stating that they have never seen the disease in infants. It may, therefore, be granted that infants and very young children are endowed with an immunity, not only the children of those who have suffered from the disease, but all children, for many of those which would come under medical care to Guayaquil are serranos—their parents poor, labouring people from the mountains, and who form a considerable proportion of the floating population of the town.

The suggestion that children are gradually immunized by being frequently bitten by infected mosquitoes may be immediately put aside, for other things being equal, would not adults have at least as good a chance of acquiring such immunity?

This immunity is a thing which gradually wears off, as is evidenced by the fact that the number of cases amongst children increases with age.

The small number of figures collected by me in the records of the Asilo Mann, may be arranged as follows:—

Ages	4	5	6	7	8	9	10	11	12
Number of cases	2	5	3	5	3	6	7	9	3

(Many children of 12 years would go to the General Hospital.)

If children are born with absolute immunity which they

gradually lose, it is easy to understand how they acquire a permanent immunity by continually living exposed to infection. As they lose 'infancy immunity' they are subject to one or more slight undiagnosable attacks of fever, *i.e.*, they receive doses of the virus which would in a non-immune adult produce grave illness, but which their remaining partial immunity largely neutralizes. Thus by these gentle vaccinations they acquire a life-long protection.

Two cases in this way interesting, were brought to my attention.

Two girls, of German parentage, born in Guayaquil, had not suffered from yellow fever till they were respectively four and five years of age. At this time they were sent to Germany, and remained there for six years.

Within a few months of their return, both suffered from definite attacks of yellow fever. During their earlier childhood the amount of yellow fever present in Guayaquil was similar to that existing on their return. Their 'infancy immunity' protected them during their earlier residence in the endemic area. During their stay in Europe this wore off, and they had not had sufficient opportunity to establish a perfect 'life immunity.'

How do children come to have this very peculiar immunity to a certain disease?

Dr. Pareja, of Guayaquil, suggested to me that as the liver in children is larger in proportion to the body than is the case in adults, it may have some function or secretion absent in the adult and which has the power of combating the yellow fever virus. This suggestion is useful and might be applied to other organs of the body. The difficulty of experiment in the matter is obvious, but if this property of children is common to other young mammals, it might have its use either as a protective or as a curative agent.

Treatment

In my notes of cases in the appendix I have omitted practically all mention of treatment, and that for the reason that I saw none that had any particular action on the course of the disease.

Treatment limits itself to purgation, combined with occasional bleeding in the early and congestive stages of the fever, alkaline waters (*e.g.*, Vichy) to counteract the lessened alkalinity of the blood, alkaline draughts, champagne and ice to allay the vomiting.

Injection of artificial serum in collapse from loss of blood, vomiting and in acute oliguria and anuria, in the latter case aided by a variety of diuretics, especially teocine and digitalis. Caffeine, injections of camphor oil, and strychnine are given as cardiac stimulants.

Cold or tepid baths are administered about four times a day in some cases, and, it is said, with good results. Hot fomentations may somewhat remove the abdominal pains.

All these will at times give relief and aid the patient to recover, but nothing alters definitely the course of the disease.

It is stated that the coagulability of the blood is much lowered in yellow fever. It may be that this is caused by the phagocytosis of blood platelets, which is sometimes seen to occur. To increase the coagulability, calcium chloride has been administered by the mouth and intravenously, but without any recognizable action.

Diagnosis

The classical symptoms of yellow fever may be given as follows:—Pyrexia, early congestion, bradycardia, albuminuria (increase of albuminuria with fall of temperature), oliguria, late icterus, and black vomit. Of these, pyrexia and albuminuria are the only ones that show any constancy. Had we some fine laboratory test for the disease, it may be that in the mildest cases albuminuria would also be sometimes absent. This inconstancy renders certain diagnosis in many cases impossible. One must be dealing with a possible non-immune who has been liable to infection, and then eliminate other diseases. If, after this, we have any four of the above signs left, the case should, from a sanitary point of view, be considered as yellow fever.

With regard to the suggestion made by Sir Ronald Ross that intestinal protozoa may be accountable for bradycardia, I have during my visit to South America seen two cases—a trichomonas and a protozoon, which I did not recognize. In the first there was tachycardia; in the second the pulse ran fairly with the temperature.

Statistics

During the year 1913, 318 cases of yellow fever were reported, with 186 deaths (57 per cent.)

Of plague, there were 774 cases, with 304 deaths (39 per cent.).

The general mortality of the town is given as 53 per thousand.

Following cabled instructions, I left Guayaquil on the 8th January, in order to proceed to Trinidad. On arriving at Panama, I was informed at the British Legation that there had been no cases of yellow fever reported from Trinidad since 30th December. It was already 15th January.

The Consul-General, Sir Claude Mallet, cabled on my behalf to His Excellency the Governor of Trinidad in order to find out if it were worth my while to proceed thither for the study of yellow fever. The reply was in the negative. I, therefore, returned directly to London.

My thanks are due to Dr. Becerra, Dr. Pareja, Dr. Ycaza Bustamente, Dr. Bolona, Dr. Escolar, and Dr. Moral, for their courtesy in providing me with material for this study of yellow fever in Guayaquil.

I am especially grateful to Mr. F. Cartwright, His Britannic Majesty's Consul in Guayaquil, for his many kindnesses, both official and unofficial.

Appendix

Case I

November 2nd.—Ill for two days at Naranjito, distant 30 kilometres from Guayaquil, transported to General Hospital; epistaxis, black vomit and albuminuria observed there. He comes recently from the province of Cañar, which is free from yellow fever.

Admitted to Lazareto in a comatose condition, with traces of blood about the mouth and nostrils. Pulse small and soft, marked icterus and epigastralgia.

November 3rd.—More black vomit and melaena. Pulse small (afternoon 104), icterus marked—pupils dilated—a dull anxious appearance. Gums swollen and red, with a trace of blood about the teeth. The tongue has a dirty yellow coat and red borders.

Patient died at 6 p.m.

Autopsy.—Aet. 30, male, shoemaker; mixed race. Died eighth day of disease (3rd November, 1913). (Autopsy 4th November.)

Skeletal development and *general nutrition* good.

Skin.—Normal; rather yellow (see race).

Eyes.—Deep icteric tinging.

Fat.—Yellow.

Pericardium.—Much injected.

Heart.—Pale and somewhat fatty.

Valves.—Aortic show a perforating ulcer. Tricuspid red and thickened.

Liver.—Very pale, fatty and friable.

Spleen.—Very small.

Kidney.—On section pale yellow.

Capsules.—Very adherent.

Lungs.—Left, normal.
Right, shows large infarct and old pleuritic adhesions.

Pancreas.—Body yellowish, tail very hyperaemic.

Stomach.—Contents grumous black. Greater curvature shows hyperaemic patches.

Small Intestine.—Mucous membrane normal. Contents as of stomach.

Large Intestine.—Mucous membrane of caecum hyperaemic. Contents black grumous.

Diagnosis.—Yellow fever.

Case 15

14*th November*, 1913.—Aet. 18 years. Brought yesterday from Milagro. Has been ill since this day week. Is in a very low condition.

Eyes very injected, especially palpebral conjunctivae. Sclerae yellow. Gums very red, but not bleeding.

Tongue dry with a general fur except at tip. Fur slightly yellow and inclined to crack. There is a general livid colour of the skin, originally rather yellow (mestizo), especially marked at the extremities. No epigastralgia. Organs normal to examination.

Heart, beat weak and rapid, first sound soft. Pulse barely perceptible. On admission, temperature 102·4°. Pulse 120. This morning, temperature 103·4°. Pulse 114.

There is some pain on pressure in the epigastrium. Plentiful black vomit. Three natural small motions since admission. No urine.

Yesterday had much albuminuria. Tongue had a white fur except at tip and edges. Much epigastric tenderness.

Blood examination

Poly.	88·6
Mono.	5·0
Lymph.	6·3

Two pigmented mononuclears present. Protoplasm of polymorphonuclears stains very evenly and lightly.

15*th November*, 1913.—Yesterday afternoon, temperature 103·4°. Pulse (?). This morning, temperature 101·2°. Pulse 120. First sound at heart very weak. Radial pulse too weak to count. Eyes same as yesterday.

Gums not so red.

The patient is in a semi-comatose condition. Coldness and lividity of limbs very marked. Stasis of blood evidenced at elbows by livid patches.

There is much epigastric tenderness, which also involves the right hypochondrium.

Stools with melaena five times since 2 a.m. He passed during the night 200 c.c. of urine (light colour) containing 0·2 per cent. albumen.

There has been much black vomit.

Treatment.—Injections of oil of camphor, effervescent draughts, and teocine as a diuretic. Patient rejects water (Vichy), but retains small quantities of tea and cognac.

16*th November*, 1913.—Patient died yesterday afternoon.

No post-mortem.

Case 17

15*th November*, 1913.—Aet. 19. An Indian from the Sierra; came to Guayaquil one month ago. He spent some of this time in hospital with malaria. Has been out of hospital one week.

Has been ill two days, beginning with a shivering fit and fever.

Admitted last night. Temperature 105·0°. Pulse 104. Much albumen.

This morning he complains of headache, backache, photophobia. There is pain on pressure over the eyeballs, and general abdominal pain.

The eyes are bright, wet, injected and yellow. The palpebral conjunctiva congested. The tongue has a white fur with red tip and borders. The gums are normal. There is dried blood about the nose. (Epistaxis recurred during examination.) He has vomited a clear yellow fluid.

Heart, first sound blowy. Liver tender, not enlarged. Spleen normal.

Temperature now 103·4°. Pulse 94. The urine is small in amount, and contains albumen. (No urine this morning.)

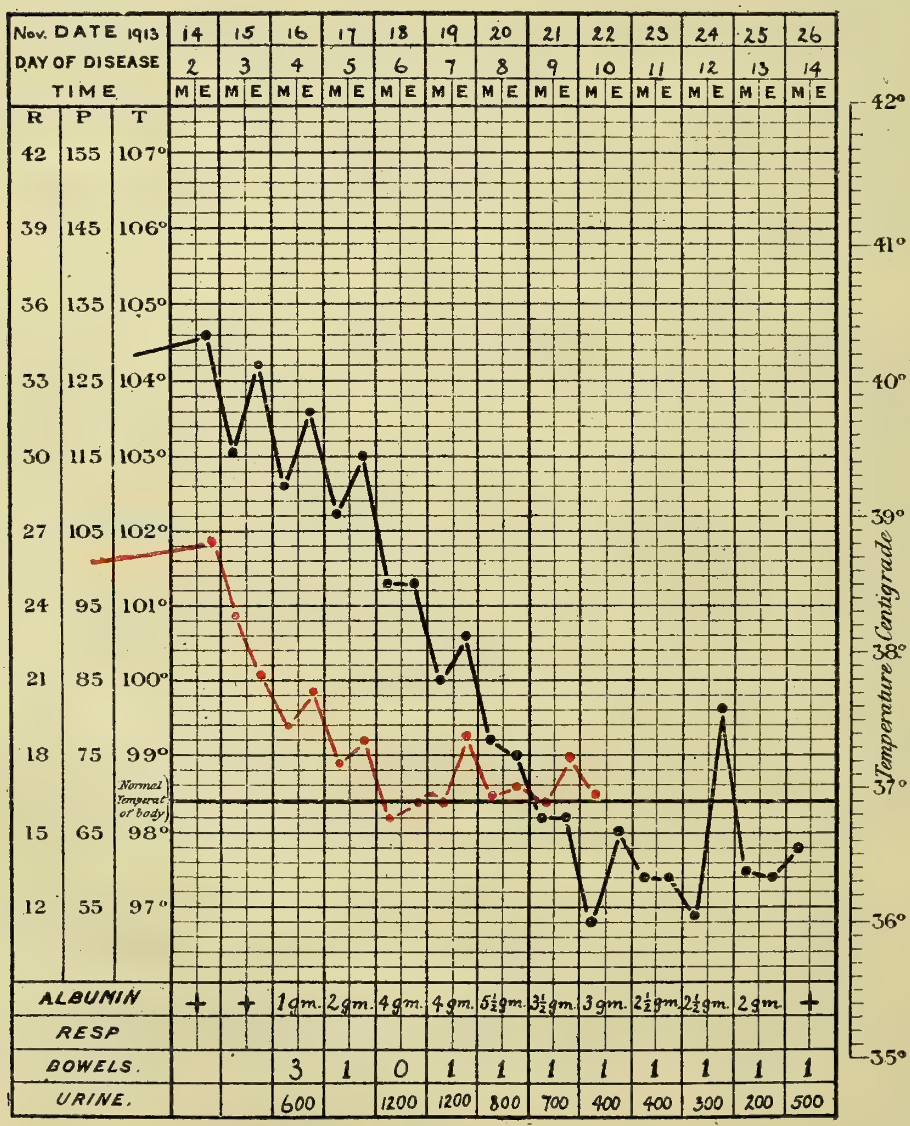


Chart 1

Blood examination

Poly.	66·3	Eosin.	0·0
Mono.	9·0	Trans.	3·3
Lymph.	20·6	Mast.	0·6

No parasites, no pigmented mononuclears. All polymorphonuclears are very lightly stained, their protoplasm is uniform and undifferentiated. Vacuolation of protoplasm, occasional.

16th November, 1913.—Had black vomit yesterday evening. To-day vomit a clear yellow. Complains much of salivation. Had three stools. Urine 600 c.c., albumen 1 gram. General condition much the same.

17th November, 1913.—Heart, first sound accentuated. Eyes neither so injected nor so yellow. Tongue white, red tip and borders. Gums normal. Tenderness about umbilicus and both hypochondriac regions. Epigastrium not tender. Yellow vomit.

18th November, 1913.—Some headache, eyes yellow but less injected. Tongue as yesterday. Heart sounds weak.

Liver tender, epigastrium slightly so. Spleen normal. Has had one normal stool. Vomits water. Looks much better. Urine 1200 c.c., albumen 2 grammes per litre.

19th November, 1913.—Eyes very yellow. Some palpebral congestion. Gums normal. Tongue cleaner. Epigastric tenderness increased. There is general hyperaesthesia. There is still nausea. Patient takes only tea, which he sometimes rejects. Urine 1200 c.c., albumen 4 grammes.

20th November, 1913.—Eyes very yellow, and some congestion of palpebral conjunctivae. No headache. Gums normal. Tongue white coat, with red tip and borders. Considerable pain in the parotid regions, and some about the suprasternal notch. Dysphagia.

Urine 800 c.c., albumen 4 grms. Bowels open twice. No vomiting. Will not remain covered. Feels hungry.

21st November, 1913.—No headache. Eyes very yellow, no congestion of conjunctivae. Parotid area less tender. Tongue and gums as before. Heart normal. Abdominal pain as yesterday. Urine 700 c.c., albumen 5½ grms. Bowels open once, says he feels better.

22nd November, 1913.—Eyes yellow. Hyperaesthesia persists in legs and abdomen. Bowels open once. Urine 400 c.c., albumen 3·5 grms.

23rd November, 1913.—Condition much the same. Urine 400 grms. Bowels open once.

24th November, 1913.—Some nausea. Hyperaesthesia less.

25th November, 1913.—No headache. Gums normal. Eyes more green than yellow. Tongue slightly coated. Patient begs for meat. Slight pain in the back. Much bile in urine. There has been slight epistaxis this morning. Urine 300 c.c., albumen 2½ grms. Heart normal. Liver and spleen normal.

26th November, 1913.—Urine 500 c.c., albumen 2 grms. No pain. Very hungry.

27th November, 1913.—Patient discharged.

Case 21

20*th November*, 1913.—Aet. 23. Has been in Guayaquil for six months. Has been seven days ill. Present condition, pregnant six months; no headache. Eyes very yellow and injected. The tongue has a brownish fur with red tip and borders; gums, rather congested. General abdominal pain. Liver tender, pain in legs, and backache. Slight general hyperaesthesia. Had profuse epistaxis and melaena yesterday, with sudden drop of temperature. Urine last twenty-four hours 200 c.c., albumen 1 grm. Temperature 98·4°. Pulse 88. Much gastric pain. No vomiting.

Blood examination

Poly.	79·3	Eosin.	0·6
Mono.	8·6	Trans.	2·6
Lymph.	8·3	Mast.	0·3

The polymorphonuclears and the large mononuclears are in many instances multi-vacuolated. Two bodies seen about the size of red blood corpuscle, and of unknown nature.

21*st November*, 1913.—There is a general convulsive twitching of arms and some of face. The face is livid. The eyes are very yellow and injected. There is congestion of palpebral conjunctiva. Patient unconscious. Last night much black vomit and one stool with melaena. Urine 200 c.c., albumen 1 grm. Gums normal. Temperature 96°. Pulse uncountable (restlessness of patient), limbs cold.

22*nd November*, 1913.—Died last night, no post-mortem.

Case 22

20*th November*, 1913.—Aet. 25. Has been four months in Guayaquil. Three days ill, some headache. Eyes slightly yellow and congested. Has slight abdominal pain. Had black vomit this morning. Has pain in right axilla. (No urine obtained.) Temperature 103·4°. Pulse 120.

21*st November*, 1913.—No headache. Eyes congested, not yellow. Tongue white with red tip and borders; there is a general erythema of skin, especially marked on face. Much backache, slight epigastric pain. There has been epistaxis this morning, no vomit. Urine 200 c.c., albumen, a trace. Polymorphonuclears very scarce. (Blood film too thin.) Most show homogeneous staining. No parasites.

22*nd November*, 1913.—Erythema, less. No headache. Eyes slightly injected and very slight icteric tinge. Gums swollen. No pain. There is some nausea. Patient had three stools with melaena, and is passing some blood per vaginam. (Not time for period.) Urine 400 c.c., albumen, a trace.

Blood examination

Poly.	58·0	Eosin.	0·0
Lymph.	20·0	Mast.	0·3
Mono.	19·0	Trans.	2·6

No parasites, no pigmented mononuclears. Slight vacuolation of polymorphonuclears. Simplicity of the shape of the nucleus of the polymorphonuclears and degeneration.

24th November, 1913.—No headache. Slight icterus and injection of eyes. Tongue clean, gums swollen. Some epigastric pain. Pulse good, bowels open once. Urine 900 c.c., albumen 1 grm. N.B.—Patient now states that it is time for her menstruation; blood continues. Patient looks much better.

25th November, 1913.—Icteric tinge of conjunctivae less. Tongue cleaner. No pain anywhere. Gums normal. Liver and spleen normal. Heart, first sound accentuated. Bowels open once.

Urine 800 c.c., albumen 1 grm. (diagnosis doubtful).

Blood examination

Poly.	50·6	Eosin.	5·3
Mono.	24·3	Trans.	1·3
Lymph.	18·3	Mast.	0·0

No parasites, no pigmented mononuclears. Protoplasm of polymorphonuclears stains homogeneously and weakly. Some vacuolation.

26th November, 1913.—Improvement continues. Urine 1000 c.c., no albumen.

27th November, 1913.—Patient discharged.

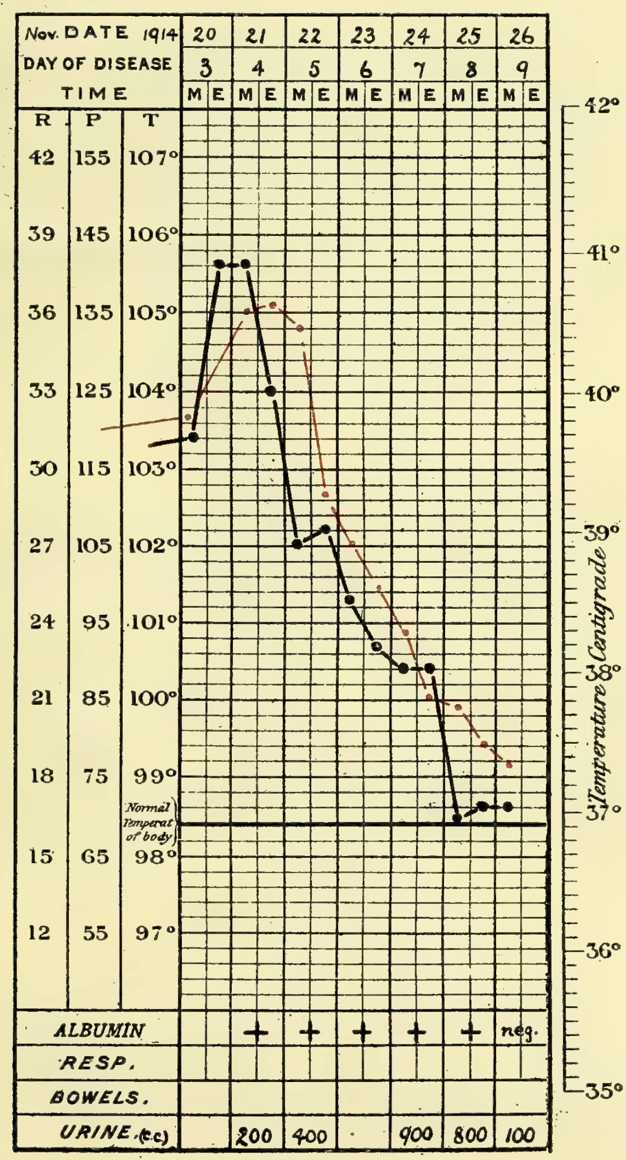


Chart 2

Case 26

24th November, 1913.—Aet. 40. Six months in Guayaquil; has been seven days ill. Temperature 104·8°. Pulse 95. Urine 400 c.c., albumen 3·2 grms. Headache. Eyes injected and yellow. Tongue, dry, with a white coat, except at tip, which is broad. Spleen normal. Tenderness of epigastrium and liver. States she has had no vomiting, but apparently has nausea. Mentally she is at present very slow.

Heart, first sound exaggerated at apex. Bowels open.

Blood examination

Poly.	96·0	Lymph.	1·6
Mono.	1·0	Trans.	1·3

This count made independently of the white corpuscles, on the edge; 150 of these were counted without a single white corpuscle other than polymorphonuclear being seen. Most were in a state of degeneration, ranging from slight vacuolation to rounded bodies of varying colour, containing purple-staining nucleus.

25th November, 1913.—Patient had some black vomit and stools with melaena yesterday afternoon; became very quiet and died some hours later.

No post-mortem.

Case 27

25th November, 1913.—Aet. 12. Has been seven years in Guayaquil. Temperature 103·2°. Pulse 108. (Third day of present illness.) Marked icteric tinge of eyes, but no congestion or injection. Spleen large. Liver normal. Heart normal. Gums red. Epigastrium tender. Tongue is coated, and has a red tip. Slight headache.

Patient states that this is the first fever he has had since coming to Guayaquil.

Blood examination

Poly.	82·3	Eosin.	0·0
Mono.	9·3	Trans.	0·6
Lymph.	7·6	Mast.	0·0

No parasites. No pigmented mononuclears.

Red blood corpuscles vary in size, some white corpuscles are vacuolated.

26th November, 1913.—Eyes injected and yellow. Complains of dizziness. Has occasional slight delirium. The liver is tender, and there is general abdominal pain. Patient has vomited a yellow material this morning. The urine contains albumen. Temperature yesterday evening 100·8°. This morning 102·7°. Pulse to-day 112. Bowels normal.

27th November, 1913.—Temperature last night 106·4°. Patient removed to Yellow Fever Lazareto this morning and died early. No more vomit, bowels not open. No post-mortem. Diagnosis doubtful.

Case 29

27th November, 1913.—Aet. 30, Boliviana. Three months in Guayaquil. Has been ill for three days. Illness began with fever and headache. The headache continues. The eyes are injected and shiny. The gums have a red line at junction with teeth. Tongue has a slight coat. Temperature 100·2°. Pulse 72. Albuminuria. Bowels open.

Blood examination

Poly.	44·0	Eosin.	0·0
Mono.	20·6	Trans.	6·3
Lymph.	29·0	Mast.	0·0

28th November, 1913.—Patient looks better. Temperature 99·3°. Pulse 78. No headache. Eyes slightly yellow and injected. Tongue clean. Gums show red line. Albumen persists. Evening temperature 37·5°. Pulse (?).

29th November, 1913.—Temperature 98°. Pulse 76. Eyes yellower. Had epistaxis last night and this morning. No pain. No albumen.

30th November, 1913.—Temperature 96·6°. Pulse 64. Slight albuminuria. Patient improving. Eyes same.

1st December, 1913.—Temperature 97·6°. Pulse 70. Slight albuminuria. Eyes clearing.

Discharged. Considered to have been probably a mild case of yellow fever.

Case 31

1st December, 1913.—Aet. 20. Seven months in Guayaquil. States that he has recently had much benign tertian malaria, at the end of which his face and feet were swollen. His present illness began two days ago with a gradual fever, without shivering fit or sweating and a sensation of sleepiness, no pain. The patient's skin is dry and scaly. The eyes are somewhat yellow, but not congested or injected. The gums are slightly spongy and swollen, but not reddened. The tongue is broad and coated. There is a presystolic murmur at the cardiac apex. No epigastralgia. There has been some nausea, but no vomiting. Some epistaxis. His temperature last night was 104·2°. This morning 103·6°. Pulse 80. Urine 400 c.c., albumen a trace. Liver and spleen are normal. There is some diarrhoea.

During examination, the patient vomited after an attack of retching, at first a small quantity of clear glairy fluid streaked with black specks, and after this a small quantity of greenish yellow bile-stained fluid.

Blood examination

Poly.	71·0	Eosin.	0·0
Mono.	11·3	Trans.	0·3
Lymph.	17·0	Mast.	0·3

No parasites, no pigmented mononuclears; definite vacuolation and occasional degeneration of polymorphonuclears. (Homogeneous staining reaction of polymorphonuclears.)

2nd December, 1913.—Eyes much yellower and conjunctiva congested. Tongue dry and red, with a slight irregular coat. Gums swollen and spongy. Heart in same condition. Spleen palpable. No pain. A sensation of restlessness. Patient had a severe epistaxis last night, this was followed by black vomit, and melaena this morning. Temperature 104·4°. Pulse 85. Urine 300 c.c.

Albumen 0·5 grms.

Blood examination

Poly.	75·6	Eosin.	0·0
Mono.	8·6	Trans.	2·0
Lymph.	13·6	Mast.	0·0

No parasites, no pigmented mononuclears. Vacuolation of polymorphonuclears slight. One polymorphonuclear seen, round nucleus, ? degenerate. (Homogeneous staining reaction of protoplasm, 3rd January, 1914.)

3rd December, 1913.—General condition somewhat better. Eyes a greenish yellow, and congested. Tongue red, with a slight coat. Gums swollen. Spleen not palpable, but tender, as is also the liver. No epigastralgia. No headache. No other pain. Sleeps well. The murmur is not heard any longer at the cardiac apex, but the first sound is rather prolonged. There has been epistaxis, coffee-ground vomit and melaena.

Urine 400 c.c., albumen 1 grm.

Blood examination

Poly.	80·6	Eosin.	0·3
Mono.	9·6	Trans.	2·0
Lymph.	7·3	Mast.	0·0

No parasites, a few pigmented mononuclears. Vacuolation of the polymorphonuclears more frequent than yesterday; also some degenerate forms seen. Rounding of polymorphonuclear nuclei marked, protoplasmic staining often weak.

4th December, 1913.—Patient's condition continues much the same—restless, some general hyperaesthesia—finds prick of needle very painful. Black vomit, epistaxis, and melaena.

4th December, 1913.—Urine 300 c.c., albumen $2\frac{1}{2}$ grms.

5th December, 1913.—Patient died at 3 a.m.

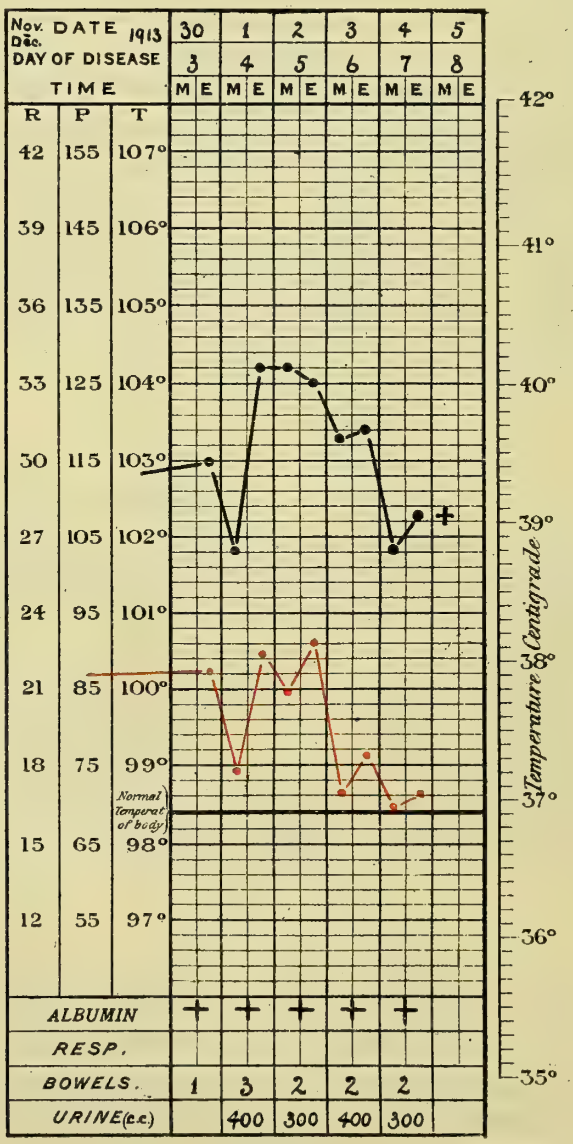


Chart 3

CASE 32

1st December, 1913.—Aet. 14. Three months in Guayaquil.

Has had no previous illness. This is fifth day of present illness. It set in with a gradual fever and headache, but with no other pain. There is some icteric tinging of conjunctiva, but no injection. The tongue has a white coat. There is some epigastralgia. The splenic region is tender. Liver and heart normal. There is a history of epistaxis (clotted blood about nostrils) and of his having vomited some blood. The stools contain melaena. An acute early lymphadenitis in the anterior cervical triangle was discovered during the examination.

30th November, 1913.—Temperature, evening, 103·4°. Pulse 86.

1st December, 1913.—Temperature, morning, 102·6°. Pulse 74.

Urine 210 c.c., albumen 1 grm. per litre.

Blood examination

Poly.	86·3	Eosin.	0·0
Mono.	8·0	Trans.	1·3
Lymph.	4·3	Mast.	0·0

No parasites, no pigmented mononuclears. Marked vacuolation and some degeneration of leucocytes, especially polymorphonuclears. Form with round nucleus seen.

2nd December, 1913.—Patient had profuse epistaxis, black vomit, and melaena last night, and died at 4 a.m. this morning.

CASE 34

5th December, 1913.—Aet. 19. Has been five months in Guayaquil. Has been ill six days. Skin damp and yellow. Eyes yellow and dull. Palpebral conjunctiva congested. The gums are redder than normal. The tongue is deep red, and has a slight brown coat, clean at edges and tip. Heart is normal. Liver is tender. Spleen normal. Some epistaxis, slight nausea, no vomiting. Constipation. Temperature yesterday morning 101·2°. Yesterday evening 102·4°. This morning 98·0°, and pulse 72. The patient is very anxious. There is marked albuminuria.

Blood examination

Poly.	61·6	Eosin.	1·3
Mono.	18·3	Trans.	0·6
Lymph.	14·6	Mast.	3·3

No parasites. No pigmented mononuclears.

Two vacuolated polymorphonuclears seen. Also some degenerate forms; one marked.

6th December, 1913.—Patient has no headache. Eyes very yellow and congested. The throat is painful. Some dysphagia. Tongue red with a slight coat. Gums look normal, but bleed a little. The heart is normal. The liver is painful. Spleen tender. There is epigastralgia. No vomiting nor nausea. The bowels have not been open.

Blood examination

Poly.	59·6	Eosin.	4·6
Mono.	15·3	Trans.	3·6
Lymph.	15·3	Mast.	1·3

No parasites. No pigmented mononuclears.

7th December, 1913.—Patient's condition remains the same. He lost a little blood from the nose yesterday afternoon. Very little pain.

8th December, 1913.—Condition of eyes the same. Gums are spongy, with white patches. The tongue has a slight brown coat. The heart is normal. Liver, epigastrium, and spleen are painful on pressure. The bowels were open once yesterday as a result of an enema. Patient has slight backache, and feels very weak. He sleeps well. Has much thirst. The urine has much bile. Patient had a bilious vomit yesterday.

9th December, 1913.—Eyes are yellow, no congestion. The tongue is clean. Gums as yesterday. There is some backache, and some pain when pressure is exerted over the umbilicus. No epigastralgia. Heart, liver, and spleen are normal. There has been no vomiting. Urine 600 c.c., albumen 1 grm. The bowels have not been open.

10th December, 1913.—Patient feels much better. Eyes yellow. The tongue is raw. The gums have a white film. Heart, liver, and spleen are normal. No pain. Urine 900 c.c., albumen a trace. Discharged 12th December, 1913.

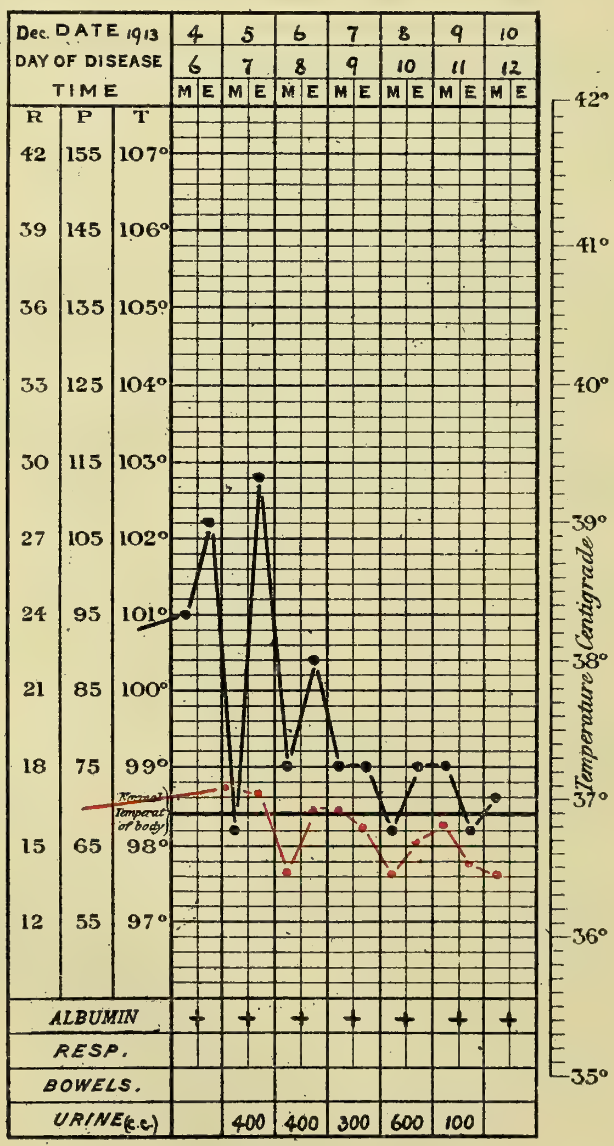


Chart 4

CASE 37

8th December, 1913.—Aet. 18. From Sierras. Has been four months in Milagro (yellow fever centre). She felt ill in Milagro, and was brought here yesterday. This is the fifth day.

The illness began with headache and vomit (food). No rigor. She felt feverish, and developed an acute backache. There is congestion of the palpebral and injection of the ocular conjunctiva, but no icteric tinge; the eyes are bright. The face has a peculiar livid, flushed appearance. The gums are normal. The tongue is clean. There is a light hyperaemia about the skin of the lower thorax. She has had no haemorrhage except per vaginam—this she ascribes to her period (she was delivered of a child forty days ago). The heart is normal. The epigastrium and liver are tender. The spleen is not palpable. Patient has general abdominal pain, especially about umbilicus and right iliac fossa. She complains of much headache, and cannot sleep.

Temperature yesterday afternoon 102·4°. Pulse 100. This morning temperature 98·6°. Pulse 80, and of fair quality. Urine 400 c.c., albumen ½ grm.

Poly.	62·0	Eosin.	1·3
Mono.	18·3	Trans.	6·3
Lymph.	11·0	Mast.	1·0

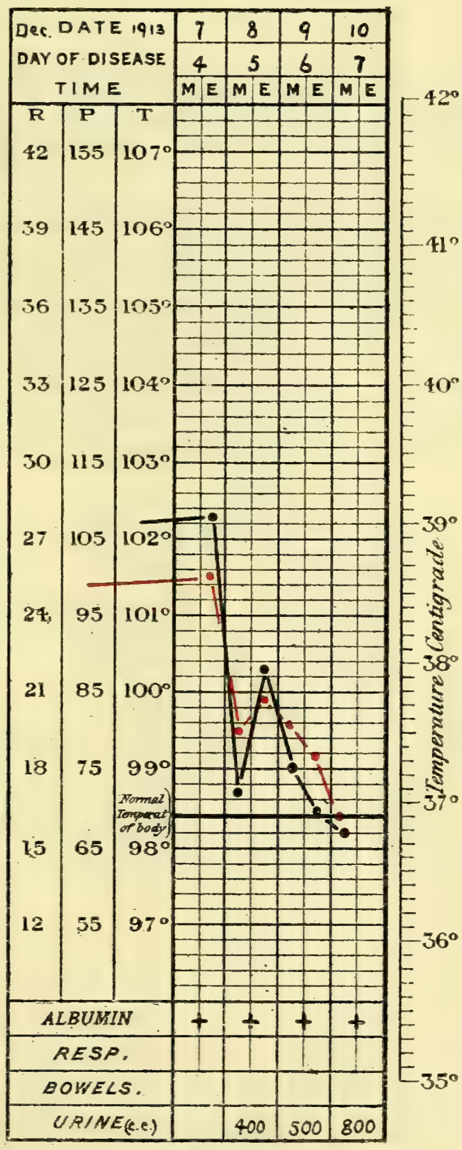


Chart 5

No parasites, no pigmented mononuclears, some vacuolation of polymorphonuclears and of large mononuclears. The polymorphonuclears are sometimes much stippled with dark brown dots.

9th December, 1913.—Patient has some improvement in the headache. The palpebral conjunctiva is very congested, and the ocular injected; there is some slight discharge from the eyes. The tongue is clean, the gums are red. Heart: first sound at apex, soft.

There is some epigastric pain on pressure. Liver and spleen are normal. Pressure over the umbilicus causes acute pain. There is also some general abdominal pain. The hyperaemia of the thoracic skin is not seen. Patient vomited some water this morning. Vaginal blood less in amount. Urine 500 c.c., containing a trace of albumen.

10th December, 1913.—Patient's face is rather yellow, eyes injected. Tongue and gums are normal. Heart, liver, and spleen normal, some pain on pressure over the umbilicus, slight backache, some nausea. Vaginal blood less. Bowels open once.

Albumen ½ grm.

12th December, 1913.—There has been a gradual disappearance of symptoms—patient discharged to-day.

Case 38

14th December, 1913.—Aet. 11. Seen in the private practice of Dr. Moral. Born in Guayaquil, and has always lived here and in the surrounding country. This is the 6th day of the illness, a fever of gradual onset, with slight remissions.

Patient at present semi-comatose and hyperaesthetic, to the extent that she cries out when touched. Conjunctiva yellow and injected, lips red. Tongue not seen, but stated to have very red borders, with a whitish brown coat in the middle; gums very red, a trace of blood about the lips. Temperature 101°. Pulse 84, and of good quality. There is a slight mitral systolic murmur. There is acute epigastralgia. There is a light flush of the whole skin, which shows yellow on pressure. There has been anuria for forty-eight hours. There has been no vomiting.

Blood examination

Poly.	74·0	Eosin.	0·0
Mono.	6·3	Trans.	2·6
Lymph.	16·3	Mast.	0·6

No parasites. No pigmented mononuclears.

There is a very general degeneration of the polymorphonuclear leucocytes; many stages seen.

22nd December, 1913.—Am informed that anuria disappeared; albuminuria found. Black vomit occurred, melaena, and death.

Case 39

15th December, 1913.—Aet. 22. Six months in Guayaquil. He has been ill for five days. The illness began with slight headache and fever, no vomiting, but a little sweating. He has been three weeks in hospital for dysentery. Temperature 100·2°. Pulse 80. Palpebral conjunctiva somewhat congested; ocular, markedly injected. The tongue is moist, with a general white coat. The

gums are discharging pus. Heart, liver, and spleen are normal. There is pain in the left iliac fossa. The dysenteric symptoms returned with onset of fever. Had five stools this morning—two of them contained blood.

There is slight albuminuria.

Blood examination

Poly.	81·0	Eosin.	0·3
Mono.	7·3	Trans.	2·0
Lymph.	8·6	Mast.	0·6

No parasites, no pigmented mononuclears. There is vacuolation and early degeneration of the polymorphonuclears (evidenced by simplicity of shape of nuclei). There is a tendency, on the part of the polymorphonuclears, to phagocyte blood platelets.

16*th December*, 1913.—Temperature 99·2°. Pulse 72. No headache. Eyes yellow, but not congested or injected; gums red (discharge), tongue cleaning. Heart, liver, and spleen normal. There is no epigastralgia, there is pain in both iliac fossae. Albuminuria increased. Patient had two stools with blood this morning.

Blood examination

Poly.	77·6	Eosin.	3·0
Mono.	7·6	Trans.	2·0
Lymph.	9·6	Mast.	0·0

No parasites. No pigmented mononuclears.

There is some vacuolation and degeneration of the polymorphonuclears, but not so marked as yesterday.

17*th December*, 1913.—Temperature 97·8°. Pulse 64. A trace of albumen. No headache; eyes have a slight yellowish tint and slight congestion. Gums normal. Tongue clean. Liver and spleen normal. There is some epigastralgia. Patient had two bloody stools to-day. (I am inclined to consider this a mild case of yellow fever. Dr. Escolar disagrees.)

Case 40

16*th December*, 1913.—Aet. 33. Three months in Guayaquil. This is the fifth day of his illness. Began with shivering fit, some headache and fever. Patient states that he became delirious. He has temperature 100°. Pulse 88. A slight headache. The conjunctiva injected. The gums very red. The tongue is dry and has a general coat. The skin of the trunk is hyperaemic. The heart is normal. Liver and spleen are painful on pressure, and there is slight epigastralgia. The patient vomited last night and this morning. The last emesis was streaked with blood. There is general abdominal pain, especially marked in the umbilical and left iliac regions. The backache is severe, and the limbs are aching. The bowels are free. There is much albuminuria.

The patient complains of photophobia and gets little sleep.

Blood examination

Poly.	54·6	Eosin.	3·6
Mono.	21·0	Trans.	2·6
Lymph.	17·3	Mast.	0·6

No parasites, no pigmented mononuclears. There is vacuolation and degeneration, evidenced by simplicity of shape of nucleus, and sometimes by lack of staining in the protoplasm.

17*th December*, 1913.—Patient had some headache. The eyes are congested. The gums are red. The tongue is rather dry and has a general slight coat. The skin of the trunk is hyperaemic. The heart's first sound is soft. There is pronounced epigastralgia. Liver and spleen are tender.

The lower portion of the abdomen is tender on pressure. The patient vomited this morning a bilious material flecked with black spots. He has had several fluid motions. Urine 400 c.c., albumen 1½ grms.

Blood examination

Poly.	50·0	Eosin.	4·6
Mono.	17·3	Trans.	5·6
Lymph.	20·3	Mast.	2·0

No parasites, no pigmented mononuclears. The polymorphonuclears show rare vacuolation, and are generally normal in appearance; rarely a tendency to simplicity of form of the nucleus is seen.

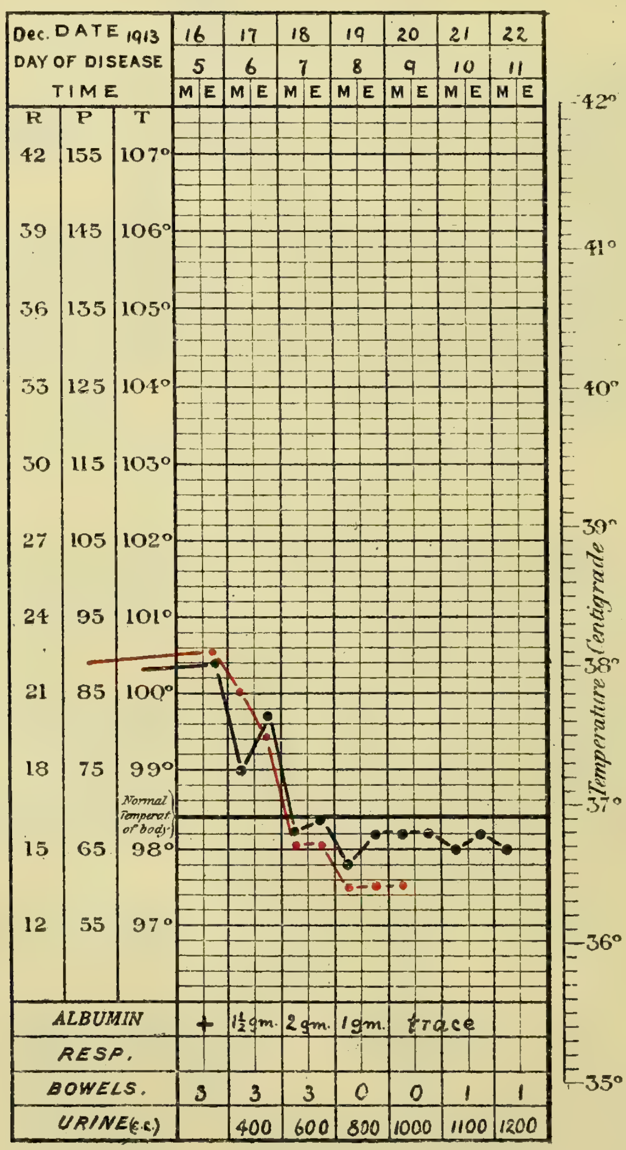


Chart 6

18th December, 1913.—Patient has some headache, the eyes are congested, and show a slight icterus. The tongue is moist, with a brownish coat. The gums are red. The skin is less hyperaemic to-day. The heart is normal. The spleen is normal. The liver is painful; there is some epigastralgia and general abdominal pain. There has been no further vomiting, but some nausea; bowels open three times. Urine 600 c.c., albumen 2 grms. per litre.

19th December, 1913.—Patient complains of slight headache. Gums less red, the tongue is cleaning. The eyes are much less injected, and are slightly yellow. The skin is hardly hyperaemic

There is a little tenderness about the liver, epigastrium and abdomen generally. The spleen is normal. Patient vomited clear liquid last night. Urine 800 c.c., albumen 1 grm.

20th December, 1913.—Patient continues to improve. There is very slight headache. The eyes are normal. The tongue is almost clean. Gums normal. Heart, liver, and spleen are normal. There is very slight epigastralgia and no nausea. Urine 1000, albumen a trace.

22nd December, 1913.—Patient's improvement continued, discharged to-day.

Case 44

22nd December, 1913.—Aet. 26. Four days in Guayaquil. He felt ill yesterday morning with a heavy feeling about his body, then fever—no vomit, but nausea. He took a purge. He is now complaining of headache. The eyes are very congested and injected. The tongue has a general white coat, the gums are red and swollen. Heart, liver, and spleen are normal. There is no abdominal pain or tenderness. Albuminuria present. Temperature 100·6°. Pulse 84. (Sent to Lazareto.)

Blood examination

Poly.	88·6	Eosin.	0·0
Mono.	4·3	Trans.	0·6
Lymph.	6·0	Mast.	0·3

No parasites, no pigmented mononuclears. There is frequent vacuolation of the polymorphonuclears; the protoplasm of about half of them is light coloured. There are many grades of colour, from white with a few faintly red points (degeneration), to a normal reddish stippled appearance.

23rd December, 1913.—The patient has slight headache. The eyes are very congested, but less than yesterday. The gums are also less congested. The tongue is dry and red, with a slight coat. There is a faint presystolic murmur to be heard at the apex. The breathing is shallow and rather stertorous. The skin of the thorax (especially) is very hyperaemic. The spleen is normal. There is some epigastralgia and general abdominal pain; the liver is tender. The patient has a bilious vomit, and the stools are bilious. Urine 400 c.c.

24th December, 1913.—The patient was bled yesterday to the extent of 100 c.c. of blood. He presents a curious appearance of combined congestion and a washed-out look. There is considerable headache. The palpebral conjunctivae are congested, the ocular injected. The tongue is dry, and has an irregular coat. The gums are red and swollen, the cheeks are livid. The skin of the trunk, especially of the chest, is hyperaemic. The heart is normal. The liver and spleen are painful on pressure. There is much pain on pressure over the bladder. The extremities are livid and cold. The patient vomits at intervals a bilious fluid; the diarrhoea is also of a bilious character.

Blood examination

Poly.	93·3	Eosin.	0·0
Mono.	5·3	Trans.	0·0
Lymph.	1·3	Mast.	0·0

No parasites, No pigmented mononuclears. There is frequent vacuolation, and in a large percentage of polymorphonuclears, advanced degeneration.

25*th December*, 1913.—Patient complains of headache. The eyes are congested. The gums are red. The tongue is red, and has a light brown coat. The skin of the face and of the rest of the body is yellow. The breathing is rapid and shallow (44 per minute). The heart beat is very weak, and can hardly be felt at the radial pulse.

There is intense epigastralgia and the left hypochondrium is painful on pressure. The pain over the bladder is less. There is an ecchymosis on the right elbow. The extremities are warmer than yesterday. There is anuria. Black vomit has occurred, about 1 pint. A small viscid light-coloured stool contained spots of blood. The patient has a history of alcoholism.

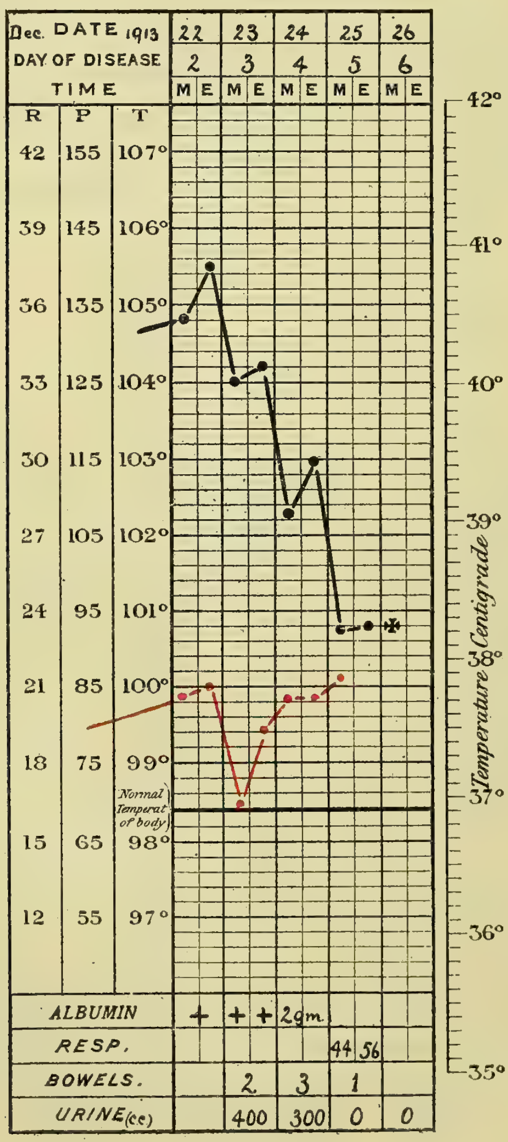


Chart 7

Blood examination

Polymorphonuclears are so completely degenerated that only a few can be recognised as such with certainty. There were about 3 per cent. each of large mononuclears and lymphocytes. No other leucocytes seen.

Afternoon.—The patient's breathing is now 56 per minute. Radial pulse uncountable, a bruise appears after slight pressure. An intravenous injection of 2 per cent. calcium chloride given (200 c.c.) by Dr. Valenzuela. Anuria continues. Patient has vomited about half a chamber full of semi-digested blood during the day.

26th December, 1913.—Patient died at 7.30 a.m.

Post-mortem examination (Dr. Valenzuela).—The skeletal development and general state of nutrition is very good. The skin has a general livid blue colour, the sclerotics are intensely yellow. Rigor mortis is very marked ; the abdomen is not distended.

The subcutaneous fat is very yellow.

Lungs.—Congested.

Heart.—Left ventricle contains some ante-mortem clots. The mitral valve shows a sub-endocardial haemorrhage on the ventricular surface of one of the flaps. There are several others about the chamber.

Liver is not enlarged, and varies from a very light brownish yellow to green in different parts. On section it is of a general light yellow ; very friable and congested.

Stomach contains a small quantity of black grumous fluid, with here and there inspissated particles adhering to the mucous membrane. The latter is stained darkly by the fluid, and shows here and there arborescent injected areas.

Kidneys are congested and yellowish. The capsule strips readily, being already raised in places by a gas. The right kidney shows a small cyst immediately under the capsule. The suprarenal capsules have undergone advanced fatty degeneration and appear as oily cavities.

Spleen is a little larger than normal.

Bladder shows arborescent injected areas in various parts of its mucous membrane ; it is completely empty of urine.

Case 45

22nd December, 1913.—Aet. 28. Two years in Guayaquil. This is the first time she has suffered from fever in this town. She fell ill the day before yesterday, in the morning, with a shivering fit, giddiness, and epigastric pain, accompanied by dyspnoea and vomiting of bilious fluid. She took a purge. The fever increased.

She now has a sensation of giddiness. The eyes are not injected, but the sclerae are yellow. The tongue has a general white coat. The gums are normal. The first heart sound is soft, especially about the tricuspid area. The right upper lobe of the lungs is dull at the back and there are some crepitations, but no cough. There is marked epigastralgia ; liver and spleen are normal. There is a large quantity of albumen. Her menstrual period has come on, and she is losing much more blood than usual.

Temperature last night 103·8° F., this morning 104°. Pulse 84.

Blood examination

Poly.	81·3	Eosin.	0·0
Mono.	10·0	Trans.	1·0
Lymph.	7·6	Mast.	0·0

No parasites, no pigmented mononuclears. Polymorphonuclears are practically normal.

23rd December, 1913.—Patient still complains of giddiness. The eyes are congested and injected. The tongue has a white coat. The gums are normal. There is some intermission of the heart beat, and occasionally a faint systolic murmur is heard at the apex. The condition of the lung is the same. There is slight epigastralgia. Liver and spleen normal. There has been no vomit, and the bowels have not been open. Albuminuria continues. The menses are less abundant.

Blood examination

Poly.	86·0	Eosin.	0·0
Mono.	9·0	Trans.	1·0
Lymph.	4·0	Mast.	0·0

No parasites, no pigmented mononuclears. The polymorphonuclears show some vacuolation. Their protoplasm is sometimes very pale, and sometimes very small in amount. The nuclei are frequently very small and dark, and simple in shape. There is occasional phagocytosis of blood-platelets by the polymorphonuclears.

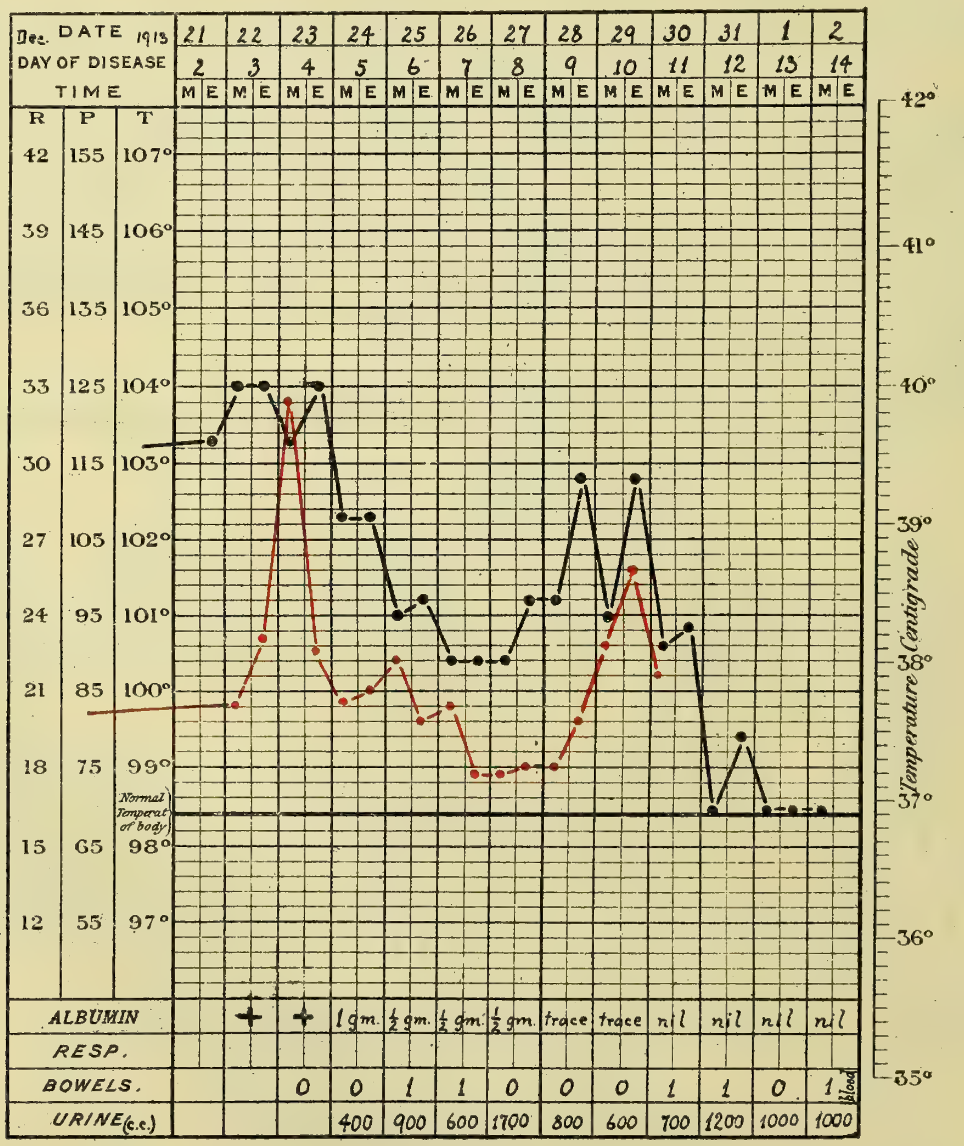


Chart 8

24th December, 1913.—There is no headache. The eyes are slightly yellow, the tongue is dry with a general white coat. The gums are normal. The lung is unchanged. There is no epigastralgia, the liver and spleen are normal. The menses have ceased. There is no vomiting, but nausea is present. The bowels are constipated.

Blood examination

Poly.	86·3	Eosin.	0·0
Mono.	5·3	Trans.	5·0
Lymph.	3·3	Mast.	0·0

No parasites, no pigmented mononuclears. There is occasional degeneration of the polymorphonuclears, as evidenced by greatly reduced reaction of protoplasm, and sometimes by the fragmentation of the protoplasm, apparently resulting from excessive vacuolation.

25th December, 1913.—No headache; the eyes are slightly yellow. The tongue is dry and has a general coat. The gums are normal. The heart has a systolic murmur. There is no epigastralgia. Liver and spleen are normal. Bowels were open once after an enema.

26th December, 1913.—Patient looks much better; she has been combing her hair. No headache; eyes markedly yellow. The tongue is cleaning, gums are normal. Heart has a systolic murmur at the apex. There is slight epigastralgia; no vomiting. The bowels have not been open.

Blood Examination

(25th December, 1913)

Poly.	83·3	Eosin.	1·0
Mono.	10·3	Trans.	0·6
Lymph.	4·6	Mast.	0·0

No parasites, no pigmented mononuclears. The polymorphonuclears show occasional vacuolation and frequent degeneration, though not of an advanced character. There is some phagocytosis of the blood platelets by these cells.

27th December, 1913.—

Blood examination

(26th December, 1913)

Poly.	79·0	Eosin.	1·0
Mono.	8·6	Trans.	2·0
Lymph.	9·0	Mast.	0·3

No parasites, no pigmented mononuclears. The polymorphonuclears are generally very slightly stained in their protoplasm. There is rare vacuolation and phagocytosis of blood platelets.

Patient's condition much the same. Tongue cleaning. The heart murmur is well defined. No abdominal pain.

28th December, 1913.—There is apparently no change in the patient's condition.

Blood examination

Poly.	84·3	Eosin.	0·3
Mono.	6·3	Trans.	1·6
Lymph.	6·6	Mast.	1·3

There are very rare pigmented mononuclears, no parasites. The polymorphonuclears are mostly very lightly stained in their protoplasm, but are of good shape.

31st December, 1913.—Patient looks washed-out. The occipital headache has disappeared, feels better. The systolic murmur is hardly audible.

Blood examination

Poly.	62·3	Eosin.	1·3
Mono.	13·6	Trans.	3·0
Lymph.	18·3	Mast.	1·3

No parasites. Some pigmented mononuclears.

The polymorphonuclears are frequently understained. There is no vacuolation of their protoplasm, inclusions of a blue-staining substance (Giemsa) are frequently met with. Sometimes the blue body is free in the protoplasm (cell fragments ?). Convalescence continued. Patient discharged 3rd January, 1914. Diagnosis doubtful.

Case 46

23rd December, 1913.—Aet. 20. Has been one month in Guayaquil, and has been sick for one week. The illness began with headache, fever, and pronounced constipation. He now has a headache ; the eyes are congested. The tongue has a central coat and red edges. The gums are normal. The first sound of the heart is soft. The liver and spleen are painful on pressure.

There is some epigastralgia, and much pain in the iliac fossa. Temperature 102°. Pulse 112. Albuminuria.

Blood examination

Poly.	88·6	Eosin.	0·0
Mono.	6·3	Trans.	1·0
Lymph.	3·6	Mast.	0·3

No parasites, no pigmented mononuclears. The polymorphonuclears have many of them a very white, unstained protoplasm. Many are vacuolated.

24th December, 1913.—The patient has no headache. The eyes are injected, the face is flushed. The tongue has a central white coat, the gums are normal. The first sound of the heart is soft. There is some epigastralgia, and pain over the liver and bladder.

Blood examination

Poly.	82·6	Eosin.	0·0
Mono.	9·3	Trans.	1·6
Lymph.	6·0	Mast.	0·3

There is a good deal of vacuolation of the polymorphonuclears. In some cases the protoplasm is entirely broken up. In other cells it is completely white, the edges being very indistinct. The nucleus is sometimes small, but generally unaffected. There are no parasites, but one pigmented large mononuclear was seen.

25th December, 1913.—Patient had some headache. The palpebral conjunctivae are congested, the ocular injected. The face is flushed. The tongue has a central white coat with red edges. The gums are normal. The first sound of the heart is weak. There is epigastralgia. Liver and spleen are normal. Some pain over the bladder, and slight backache. No vomit. There has been one stool with melaena.

26th December, 1913.—There is no headache. The patient appears more stupid than usual. The congestion and injection of the conjunctiva continues. The tongue is coated centrally. The gums are normal. The first sound of the heart is very soft and is inaudible except at the apex. There is some epigastralgia. The patient has vomited a brown bilious matter, and has had one brown liquid stool.

Blood examination

Poly.	71·3	Eosin.	0·6
Mono.	16·6	Trans.	2·0
Lymph.	9·3	Mast.	0·0

No parasites, a few pigmented mononuclears. Vacuolation of the polymorphonuclears is not very common, but these cells are very frequently degenerated—generally evidenced by loss of staining reaction of the protoplasm.

27th December, 1913.—Condition rather better. Tongue cleaner, heart improved. There is some epigastralgia; no nausea.

Blood examination

Poly.	85·6	Eosin.	1·0
Mono.	7·0	Trans.	2·0
Lymph.	4·3	Mast.	0·0

No parasites, no pigmented mononuclears. The polymorphonuclears are improved in appearance, only a few of them have not taken their normal staining. Only one was vacuolated.

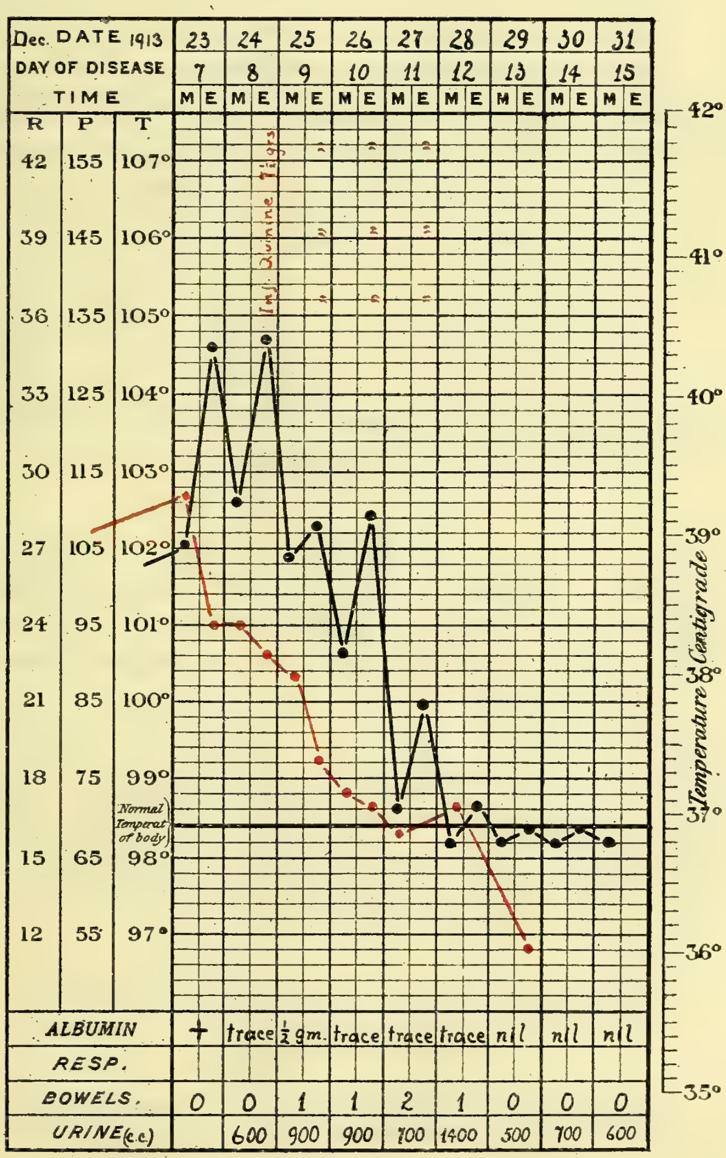


Chart 9

Blood examination

Poly.	87·0	Eosin.	0·3
Mono.	6·3	Trans.	1·6
Lymph.	4·6	Mast.	0·0

No parasites, no pigmented mononuclears. Most polymorphonuclears are very lightly stained in their protoplasm, but of good shape.

28th December, 1913.—Eyes yellow; tongue coated. The heart is better. No pain. Patient had one diarrhoeic stool. He wants to go to work.

29th December, 1913.—Eyes more yellow. Tongue dry with a white coat. Heart normal. Some epigastralgia.

Blood examination

Poly.	78·0	Eosin.	0·3
Mono.	9·3	Trans.	1·6
Lymph.	10·3	Mast.	0·0

No parasites, no pigmented mononuclears. There is improvement in the staining of the polymorphonuclears, and most of them are now normal.

Blood examination

Poly.	73·6	Eosin.	2·6
Mono.	14·0	Trans.	0·6
Lymph.	9·3	Mast.	0·0

No parasites, some pigmented mononuclears. There is rare vacuolation of the polymorphonuclears, which are in general normally shaped and stained.

30th December, 1913.—Patient's condition the same.

Blood examination

Poly.	44·0	Eosin.	1·6
Mono.	28·6	Trans.	2·3
Lymph.	23·0	Mast.	0·3

No parasites, no pigmented mononuclears. The polymorphonuclears are normal. Patient discharged 1st January, 1914.

Case 47

Aet. 20. Patient is a school teacher who came from Germany some five months ago. While here he had an attack of dysentery. This is the fourth day of his present illness. Previous to coming here he vomited some blood, and bled from his gums.

He is very restless, but has no headache. The eyes are injected. The face is flushed, the tongue is very red and has an irregular white coat. The gums are red. The first sound of the heart is soft. The skin of the chest is hyperaemic. There is some epigastralgia. The spleen and liver are normal. He has vomited a bilious fluid with 'alas de mosca' (fly wings). Urine 200 c.c.

Blood examination

Poly.	75·3	Eosin.	4·0
Mono.	11·6	Trans.	1·3
Lymph.	6·6	Mast.	1·0

There are no parasites, and no pigmented mononuclears. The polymorphonuclears show much vacuolation and some phagocytosis of blood platelets. Degeneration is seen in many stages.

26th December, 1913.—The patient looks better. There is no headache. The palpebral conjunctivae are slightly congested. The cheeks are flushed. The tongue, which is denuded of most of its epithelium, has an irregular white coat. The gums are normal. The heart sounds are normal. There is slight epigastralgia. There have been two stools containing melaena. During the night the patient vomited a small amount of dark fluid, spotted with blood.

Blood examination

Poly.	61·6	Eosin.	16·0
Mono.	14·6	Trans.	0·3
Lymph.	6·0	Mast.	1·3

No parasites, no pigmented mononuclears. The film has taken the stain rather badly, but much degeneration of the polymorphonuclears is apparent (unstained protoplasm).

27th December, 1913.—Improvement continues. The eyes are very slightly injected; the cheeks are rather livid. The tongue is cleaning. There is very slight hyperaemia of the skin of the chest. Heart normal. Slight epigastralgia, no nausea.

The patient's teeth indicate congenital syphilis.

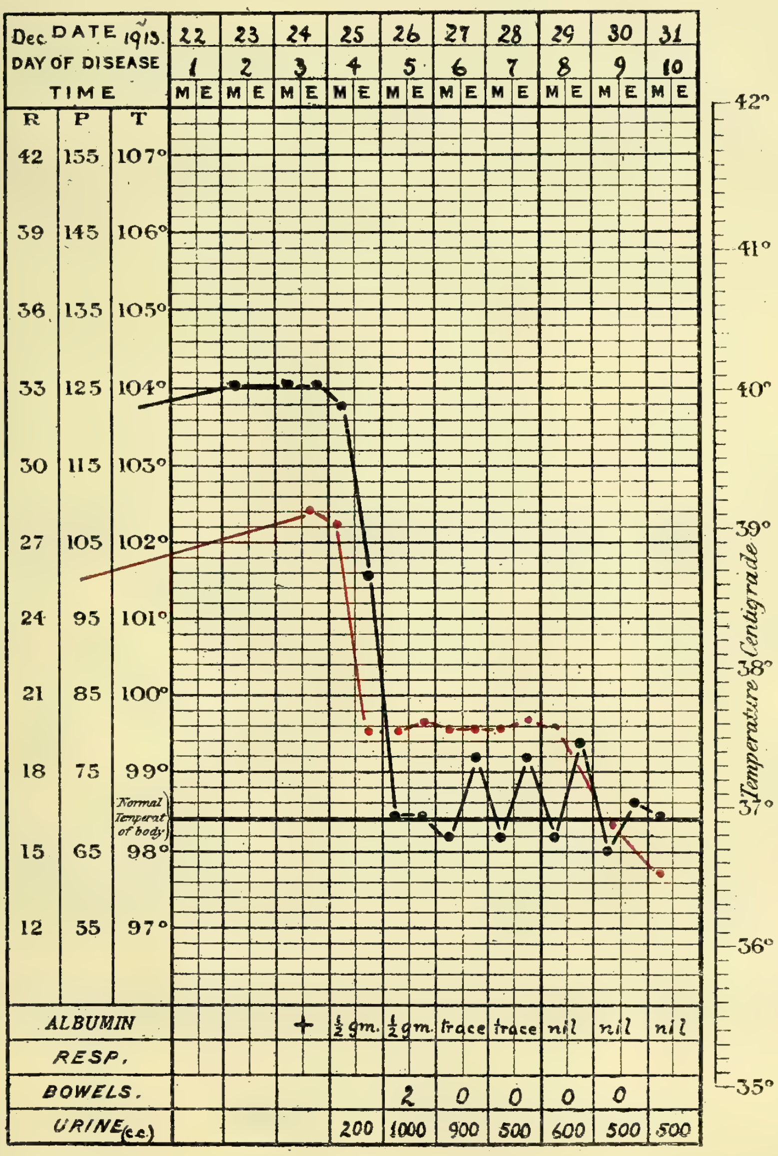


Chart 10

Blood examination

Poly.	69·6	Eosin.	7·3
Mono.	16·0	Trans.	0·0
Lymph.	7·0	Mast.	0·0

No parasites, no pigmented mononuclears. The polymorphonuclears show some improvement in shape and staining reaction, but most of them are still degenerated. The large mononuclears also show change of shape (splayed out) and light reaction. The leucocytes in this blood do not present a healthy appearance, except the lymphocytes.

28*th December*, 1913.—Patient is very weak. The eyes are not injected, but a little yellow. The face is livid. The tongue is as yesterday. The gums are a little swollen. The patient lost about six ounces of blood by the nose this morning. There is marked gastralgia. The liver and spleen are normal. The first sound of the heart is very weak. The pulse is very compressible. The skin of the trunk is livid. No vomiting.

Blood examination

Poly.	66·6	Eosin.	7·0
Mono.	10·6	Trans.	1·0
Lymph.	14·3	Mast.	0·3

No parasites, no pigmented mononuclears. The polymorphonuclears have much improved, and more than 50 per cent. of them are normal. Of the others, most have a weak protoplasm staining reaction, and some have the small rounded nucleus. The large mononuclears are normal.

29*th December*, 1913.—No headache. There is slight icteric tinging of the lower and upper portions of the ocular conjunctiva. The tongue has the ' strawberry ' appearance. The gums are slightly swollen. There is a post-systolic murmur distinctly audible a little above the nipple level. The epigastralgia has disappeared. Liver and spleen are normal. The patient is hungry and sleeps well.

Blood examination

Poly.	56·6	Eosin.	6·6
Mono.	21·6	Trans.	2·0
Lymph.	11·6	Mast.	1·3

No parasites, some pigmented mononuclears. The condition of the polymorphonuclears shows a slight improvement on yesterday.

30*th December*, 1913.—Patient's condition unaltered.

Blood examination

Poly.	59·6	Eosin.	2·0
Mono.	21·0	Trans.	4·3
Lymph.	12·0	Mast.	1·0

No parasites, some pigmented mononuclears. There is much difference in the staining reaction of the polymorphonuclears, some have a very white protoplasm, others medium, and others normal ; a few of the nuclei tend to simplicity of shape.

31*st December*, 1913.—Patient looks much better. Eyes somewhat yellow. Tongue raw with white coat in patches. The heart is better.

Blood examination

Poly.	47·0	Eosin.	2·6
Mono.	20·6	Trans.	0·3
Lymph.	28·6	Mast.	0·6

No parasites, some pigmented mononuclears. The polymorphonuclears show a weak protoplasmic staining in general.

1st January, 1914.—The patient is looking and feeling fairly well.

2nd January, 1914.—Improvement continues.

4th January, 1914.—Patient convalescent.

CASE 50

Aet. 18. Comes from Quito. Has been three months in Guayaquil. He is a printer and works at night. This is the fourth day of illness, which began with a shivering fit, headache and backache (severe).

The eyes have a slight icteric tint, and the palpebral conjunctiva is somewhat congested. The tongue has a light brown coat. The gums are more red than normal, and show slightly the appearance of having been touched with silver nitrate. The skin of the chest is not hyperaemic. The heart is normal except for a faint presystolic sound, best heard at the third costal interspace. There is no epigastralgia, no liver enlargement or tenderness; the spleen is normal. There has been no vomiting. Castor oil administered.

Blood examination

Blood film spoiled by sweat drops. A few leucocytes (polymorphonuclears) seen, some normal weak protoplasm staining, one rounded nucleus with small protoplasm.

2nd January, 1914.—There is no headache, the eyes are more yellow. The tongue has a white coat and red edges, the gums as yesterday. The face is livid. The abnormal heart sound is less distinct (digitalis). There is acute epigastralgia. The liver is slightly tender. The splenic dullness is somewhat enlarged. There is no hyperaemia of the skin, no headache, and no abdominal pain. The patient vomited a yellow fluid with light brown specks.

Blood examination

Poly.	88·0	Eosin.	0·0
Mono.	9·6	Trans.	0·0
Lymph.	2·3	Mast.	0·0

No parasites, no pigmented mononuclears. The polymorphonuclears have, in nearly all cases, no protoplasm staining reaction. Some of the nuclei are rounded. The protoplasm has often a ragged edge. The mononuclears have frequently a very large nucleus and spread-out protoplasm, which is not granular, and does not react to the stain.

3rd January, 1914.—The patient has not slept during the night, and now looks much weaker than yesterday. The conjunctivae and skin are very yellow. There is no injection of the former or hyperaemia of the latter. The tongue is almost clean, and red; the gums are as yesterday. The heart has not changed to auscultation, but to palpation appears to have a slight thrill at the apex. The epigastrium is extremely tender. The liver is painful, especially at the back; its dullness reaches about two fingers' breadth below the costal margin. Patient vomited twice a black vomit (beef tea dregs), and had seven stools with melaena. The pulse is weak. The patient is very restless, and groans with abdominal pain. (Injection of 200 c.c. 2 per cent. calcium chloride given intravenously.)

Blood examination

Poly.	86·0	Eosin.	0·0
Mono.	9·0	Trans.	0·0
Lymph.	5·0	Mast.	0·0

No parasites, no pigmented mononuclears. The polymorphonuclears very rarely have their protoplasm stained; when it is stained, it is so only to a very slight degree, and generally shows the protoplasm broken by much vacuolation. The large mononuclears are often ill-stained, the nucleus of the polymorphonuclears lightly stained and with a splayed ragged edge to the protoplasm.

4*th January*, 1914.—The patient is unconscious, but screws up his face with pain and moves restlessly at the least pressure anywhere (hyperaesthesia). The conjunctivae are a deep yellow. The skin is yellow. The radial pulse is hardly palpable. 500 c.c. of urine collected from him, but a considerable quantity has been passed in the bed. He has had three stools with melaena, and vomited a coffee-ground material several times. There are bruise marks resulting from pressure about the elbows.

Blood examination

Poly.	83·0	Eosin.	0·3
Mono.	12·0	Trans.	0·0
Lymph.	4·3	Mast.	0·3

No parasites, no pigmented mononuclears. Advanced general degeneration of polymorphonuclears on slide.

Patient died 10.30 p.m.

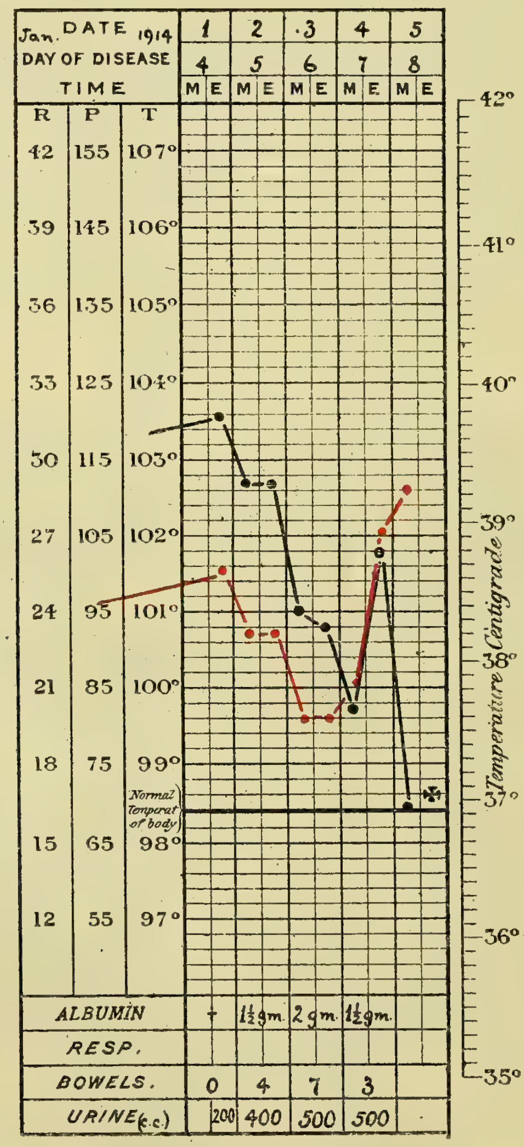


Chart II

YELLOW FEVER COMMISSION
(WEST AFRICA)
INVESTIGATORS' REPORTS

THE INCORPORATED LIVERPOOL SCHOOL OF TROPICAL MEDICINE

YELLOW FEVER BUREAU
BULLETIN

SUPPLEMENT VOLUME II

YELLOW FEVER COMMISSION
(WEST AFRICA)

REPORTS

ON QUESTIONS CONNECTED WITH THE

INVESTIGATION OF NON-MALARIAL FEVERS IN WEST AFRICA

VOLUME II.

(August, 1915)

With twelve plates, one map, and one hundred and seven charts

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YELLOW FEVER COMMISSION

(WEST AFRICA)

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TABLE OF CONTENTS

REPORT ON A SERIES OF 800 MEDICAL PYREXIAS INVESTIGATED ON BEHALF OF THE YELLOW FEVER (WEST AFRICA) COMMISSION, AT SIERRA LEONE, FROM MAY TO SEPTEMBER, 1913, WITH THE INCLUSION OF A FURTHER 300 CASES INVESTIGATED BEFORE THE FORMATION OF THAT COMMISSION

BY

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In submitting this report, I must regret its incompleteness.

To analyse and discuss some 1,100 cases of fever requires both energy and time, and I have been denied both owing to continued ill-health and my military duties since I commenced it.

Though inadequately summarised, I trust that an examination of the five volumes, which contain complete clinical and laboratory records of these 1,100 fever cases, has been of some value to the Commission.

SYNOPSIS OF THE REPORT

I. *Introduction and Preliminary Organisation*

Though my services had been asked for in February, the final cables from the Yellow Fever Commission reached me in April, when on a hunting expedition in French Guinea, and a cable from the Governor of Sierra Leone recalling me from there having reached me about the same time, I regained the Niger by forced marches, and returned to Sierra Leone by the end of the month.

The junior Investigator, Dr. Butler, and myself immediately got to work to organise the local investigation on the lines indicated by the Yellow Fever Commission, and the following points were discussed and action taken in the following instances:—

(*a*) What should constitute a fever case for the purposes of the investigation? A temperature of 100° F., and at least one day of fever, was settled on as a minimum, unless there were exceptional circumstances.

(*b*) Whether the system of sending cards* to all practitioners and military and civil medical officers, should be supplemented by a second ledger registration of all medical pyrexias investigated? This was adopted, and proved both simple and satisfactory.

Action was taken in the following instances.

(*c*) The Senior Medical Officers of the civil and military medical services were approached, and advised as to such circulars and instructions as should accompany the case cards*, which was their duty to distribute to and collect from the officers serving under them in Freetown and the Colony. The responsibility for the success of these measures lay with the Senior Medical Officer concerned; the investigator might be in a better position to further it.

(*d*) In order to provide for the co-operation of the local (native) medical practitioners of Freetown, a meeting of these medical men was called, when the card system* was explained, their co-operation in the investigation asked for, and demonstrations given as to the best methods of obtaining blood specimens, which we agreed to examine for them. All the native practitioners of Freetown attended this meeting.

The study of the problems involved in the instructions to investigators and those concerning the use which could be made of the

* An explanation of the various forms referred to in this and other reports as 'blue cards,' 'white forms,' etc., will be found in the First Report of the Commission, paragraph 8 and Appendices II and III. For convenience of classification the cards supplied to each dependency were of a distinctive colour.

mass of clinical material at our disposal was grappled with, and the organisation of the laboratories completed for the bacteriological examination of pathological material.

Hopes were entertained that by the organised and concerted efforts of the civil and military medical officers of the Colony, encouraged by the local authorities, smooth working and satisfactory scientific results would be obtained. Disappointed, however, in the end, I resigned my official position and emoluments, for reasons already given in my letter of resignation, in order to devote all my spare time and energy to an investigation of the military cases alone, a sphere in which I could be more certain of active co-operation.

While separated in theory from my personal friend and colleague, Dr. Butler, in practice we lived and worked together to our mutual benefit, and that of the cases we strove for.

The report which follows concerns the military cases alone, and certain cases among children and women, which I investigated while in charge of the Missionary Hospital.

II. *Clinical Material*

The clinical material at my disposal was provided from

(1) The patients in the military hospital at Tower Hill which serves the 250 European troops stationed in the barracks at Tower Hill, above Freetown, and those in the batteries on Wilberforce ridge some three miles to the West of Tower Hill.

(2) The officers' hospital at Mount Aureol, which provides for the 80-90 officers of the Sierra Leone Garrison.

(3) The hospital for West Indian soldiers at Mount Aureol, where the sick from the 400 odd West Indian troops, which are quartered on the high ridge to the West of the town and Tower Hill, are treated.

(4) Wilberforce hospital, which serves the 800 West African soldiers on this ridge.

(5) The small hospitals attached to the military posts of Port Lokko (15 miles), Mahanta ($34\frac{1}{2}$ miles), and Wangkefu (49 miles from Freetown), and guarding the hinterland of the Colony. The total strength of these detachments amounts to some 400 West African soldiers.

(6) The Princess Christian Missionary Hospital at Cline Town, which treats, both as in-patients and out-patients, the poorer

inhabitants of Freetown, chiefly Syrian and West African women and children.

The fact that the clinical material just referred to was drawn from different races, increased its value for the purposes of the investigation.

The 300 European N.C.O.'s and men of the garrison could be regarded as non-immunes to yellow fever, as they arrive in batches of 100 in February, July, and October, and stay but a year in the country.

A few of the non-commissioned officers, however, remain longer periods, with intervals of long leave.

The 80 odd officers of the garrison remain as a rule two to three years in the Colony, with intervals of 6 months to a year between their annual coast tours.

The Syrian cases reported came from the poorer Syrian population which lived in Freetown.

The 400 N.C.O.'s and men who form the West India Regiment remain three years in Freetown, alternating this service with a similar period in Jamaica, where they are recruited.

The immunity to yellow fever of this body of men depends to some extent on the view taken as to the endemicity of yellow fever in Jamaica. Boyce seemed to regard the island as practically yellow fever free for many years.

The 1,200 West African soldiers who garrison Wilberforce ridge and the hinterland of the Colony are recruited from among the tribes of Sierra Leone and portions of French Guinea.

The women and children in- and out-patients of the Missionary hospital are chiefly Creoles of Freetown, or belong to the native tribes of the Colony.

From the point of view of the investigation there is no difference between the so-called Creole of Freetown and the other tribes. The slave forefathers of these people were nearly all West African born, I believe; there is no white blood in these people, and they have all been on this coast for over a hundred years.

It will be seen from the above that if the endemic theory of yellow fever is accepted, the 400 Europeans could be regarded as non-immunes. The immunity of the Syrians would depend largely on the period they had lived on the coast. The immunity of the West

Indian soldiers to yellow fever would be regarded as doubtful, while the West African cases would come from among immune races.

A satisfactory feature of the investigation was the fact that all but 150 of the cases were hospital in-patients, and could be kept under observation; further, as they were mostly soldiers, they were under observation during the entire period of their illness, and from its onset. The out-patient cases are far less satisfactory to deal with, their clinical records incomplete, and the laboratory investigations limited to blood work alone.

III. *Methods of dealing with the Material*

(*a*) *Clinical Methods.* When it was realised that the system of registering fever cases on different coloured cards*, as instituted by the Yellow Fever Commission, was not suitable to cases among the troops, I decided to record every medical pyrexia in both its clinical and laboratory side in special ledger books.

It is laid down in the rules for guidance of investigators, that cases clearly shown to be ordinary malaria or other well-known diseases, should not be recorded unless of special importance. This method was not adopted, as neither the presence of malaria parasites in the blood of a patient suffering from fever, nor the fact that his clinical symptoms appeared to the observer to indicate malaria, appeared sufficient ground for suppressing the records of such a case in a country where yellow fever is supposed by some to have passed unrecognised owing to mistaken diagnosis.

It was felt that the complete clinical and laboratory records of each case should be placed directly before the Commission.

With this end in view, the complete record of every medical pyrexia which occurred was placed in ledger books prepared for this purpose. The clinical side of the case, including the temperature chart, pulse and respiration rates and clinical notes available, were recorded on one page, while all the laboratory investigations carried out on it were recorded on the opposite page.

There was a column reserved for diagnosis and any special remarks.

By these methods some five volumes of records have been compiled and placed before the Commission.

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* *Vide* note on page 354 *supra.*

They contain nearly 1,100 cases of medical pyrexias, 800 of which were recorded during the period I worked as an investigator for the Commission, while the remainder were collected from the clinical and laboratory records of cases I investigated in the earlier months of 1913, and before the Yellow Fever Commission was formed.

As nearly three-fourths of my cases come from military sources, it is needless to say that I owe the inclusion of their clinical records to the action of Col. Gerrard, my Senior Medical Officer, who ordered all temperature charts of cases, when discharged, to be sent to the laboratory, and to those of my brother officers who sent them. I further obtained the permission of the Senior Medical Officer to visit fever patients in the military hospitals, and take notes on their cases, and did so whenever possible.

It was impossible to visit every case owing to the inaccessibility of the military hospitals in Freetown, each of the three of these institutions being perched on a different hill, but endeavours were made to visit all cases in any way suspicious, and those occurring among Europeans. Unfortunately pulse and temperature rates as registered by African sick orderlies are not always trustworthy, but the records of all European cases may be regarded as reliable.

In order to study cases of fever among the Syrian population and native children, I took over medical charge of the Princess Christian Missionary Hospital, and considerable time and attention was paid to these cases owing to their importance from the point of view of the Commission.

Each of the five volumes of records had a synopsis of the cases contained in it. The diseases were grouped as to their nature, and the cases were themselves further grouped, as to whether they were complete or proved cases, incompletely recorded and useless cases, or cases of doubtful or suspicious nature.

(*b*) *Laboratory Methods of dealing with the Clinical Material*

Blood examinations. The system of examining the blood of all cases admitted to military hospitals in Sierra Leone had been practised long before the Commission started its investigation, and the system, with extra precautions, continued during the investigation.

Owing to the military laboratory at Tower Hill being a centrally-

situated one, and the clinical material widely distributed in hospitals from 2 to 60 miles away, the dry film method was used in nearly all instances. Blood smears were taken on the admission of the case, and 12 and 24 hours later if nothing had been found in the earlier examinations.

Circulars embodying such orders and that blood specimens should be taken before quinine was administered, were issued by the Senior Medical Officer. Unfortunately from the laboratory point of view, European officers and soldiers often took quinine the moment they felt ill, and before reporting sick, and it is from among such cases and the earlier ones in the investigation, when only one slide was received, that most of the cases marked 'doubtful,' are derived.

The routine method of blood examination employed was the examination of thick and thin blood smears for malaria and any other blood parasites, and a differential leucocyte count in all cases.

Between two and three thousand such examinations were carried out on these cases. *Blood cultures* were made in a few instances, and *serum tests* carried out when considered necessary.

Urine examinations. The urines of only such cases as occurred among the European troops were examined in the laboratory. The urine examination of cases in the other hospitals when done were carried out by the Medical Officer in charge of these cases, and those of many of the malaria cases are missing.

Of 150 urine examinations which time has permitted me to look up—half from each source, European and native—albumen was present in 9 of 75 cases among Europeans, and in 32 of 75 natives.

The tests applied were nitric acid and the heat test.

The presence of traces of albumen in natives is largely due, I believe, to urethral affections. Possibly ankylostomiasis so prevalent among them may also account for the presence of albumen in their urine. Casts were rarely or never found in these native albuminurias.

Over 100 *stools* were examined, chiefly for the presence of ankylostome and other helminth infections—but in a few cases from evidences of dysentery, typhoid, &c. Ankylostome ova were present in nearly half of all stools of West African soldiers, and over two-thirds of all West Indian soldiers, but only found in one instance in a European, who had lived several years in the country.

The ova of helminths found included *Trichiuris*, *Strongyloides*, *Ascaris*, and *T. saginata*.

Lymphatic gland puncture was carried out in a number of cases in investigating for trypanosomiasis, but only two cases of this disease were discovered.

Liver puncture was carried out twice.

IV. *Analysis of the Cases*

Each of the five volumes recording the 1,100 cases of medical pyrexia contained an index and analysis of these cases, so that any case could readily be looked up and examined.

Every doubtful case, i.e., every case not satisfactorily cleared up, was further recorded in detail on a white card.

It is not necessary for a detailed list of all these doubtful cases to be reproduced, but a list of 70 odd of these cases with very brief notes is appended.

These 1,100 cases are analysed in the following manner:—

Table I gives the numbers by diseases of all the completed, i.e., satisfactorily diagnosed cases in adults and the number of those cases which were omitted altogether owing to very incomplete investigation.

Table II gives an arbitrary, though useful, grouping of the 'doubtful' cases among adults.

Table III is the table of the children's cases, and includes the completed cases, the cases which should be omitted and the cases of doubtful nature.

It has been considered necessary to separate the children's cases from those of the adults, owing to the difficulty of classifying the maladies of these little people, some two-thirds of whom always harbour malaria parasites in their blood. In adults the association of malaria and fever usually signifies cause and effect, whereas in children malaria is too prevalent to adopt this view without great reservations.

Table IV gives brief details of the more important cases of doubtful nature; these cases have already been sent to the Commission fully detailed on white forms.*

Table V gives the race incidence of the diseases met with.

Table VI gives the race ratio of admission per 1,000 of strength, for malaria among the garrison of Sierra Leone.

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* *Vide* note on page 354 *supra*.

V. *Six Tables of Investigated Cases*

Table I

Giving a general analysis of diseases investigated among adults

Completed Cases

Diseases	Vol. I	Vol. II	Vol. III	Vol. IV	Vol. V	Total	Remarks
Malaria	206	180	206	45	39	676	All cases proved microscopically
Blackwater	—	1	3	—	2	6	
Trypanosomiasis ...	1	1	—	—	—	2	
Syphilis	7	5	1	—	—	13	Cases of fever due to syphilis
Tubercle (alone) ...	4	—	—	—	1	5	In a few instances malaria and tubercle were associated
Rheumatism ...	6	3	—	—	3	12	
Pneumonia ...	1	2	—	1	2	6	
Bronchitis	5	4	4	2	5	20	
Gastritis	4	7	—	—	—	11	From British troops. Temperatures rarely exceeded 99°
Pyogenic	2	5	4	2	—	13	Fever cases ultimately found to be due to pyogenic organisms
Hepatitis	—	—	—	—	2	2	
Jaundice (catarrhal)	1	—	1	3	—	5	Associated with clay-coloured stools
Ankylostome fever (alone)	6	6	8	2	—	22	These were the severer forms leading to admission to hospital
Typhoid	1	—	—	—	—	1	Only one case of typhoid was proved bacteriologically
Other cases ...	3	3	1	4	13	24	Includes a number of cases of little importance
Totals	247	217	228	59	67	818	

Incompleted Cases

Diseases	Vol. I	Vol. II	Vol. III	Vol. IV	Vol. V	Total	Remarks
—	7	10	5	2	9	33	These cases are considered incomplete owing to insufficient clinical and bacteriological investigation—none of them were in any way suspicious. Any case of at all doubtful nature is included among the doubtful group, Table II, even if it was incompletely investigated

Table II

Cases of Doubtful Nature, where no Definite Bacteriological Diagnosis could be made

These cases have been divided into sub-groups for convenience, by the following method. I grouped the cases, in the first instance, after taking into consideration (*a*) the diagnosis arrived at by the medical officers in charge of cases; (*b*) any microscopical evidence available. This grouping was checked by an independent observer, and his modifications adopted; these were slight.

Disease group	Volumes of records						Remarks
	Vol. I	Vol. II	Vol. III	Vol. IV	Vol. V	Total	
1.—Grouped as probable malaria on clinical + bacteriological grounds ?	7	14	4	2	6	33	These cases as well as those in Group 2 were diagnosed malaria by the medical officers in charge of cases. 21 of the 33 cases occurred either before the Commission started or within the first month
2.—Grouped as probable malaria on clinical grounds only ?	16	—	—	—	—	16	These cases occurred early in 1913, before the Commission started, and apparently only one blood examination was done in most cases—possibly after quinine administration
3.—Enteritis and pyrexia ?	5	11	7	—	2	25	A group of cases where diarrhoea was a prominent symptom
4.—Ankylostomiasis ?	—	—	—	—	12	12	Cases of slight prolonged fever among out-patient Africans, whose blood showed a very high eosinophil count
5.—Kala-Azar ? ...	—	—	—	—	5	5	Cases of fever associated with big spleens and some leucopenia
6.—Pyrexia of uncertain origin ?	—	7	4	2	1	14	Cases difficult to diagnose
	28	32	15	4	26	105	

TABLE III

CASES AMONG CHILDREN

(As two-thirds of all children in Sierra Leone carry malaria parasites in their blood, a classification of their diseases has been carried out on different lines to that of the adults.)

COMPLETED CASES

A.—Cases of fever when malaria was the only obvious cause		33
B.—Cases of fever when some other disease was associated with the malaria parasites in the blood		60
(1) When bronchitis was present ...	31 cases	
(2) When whooping cough was present	15 ,,	
(3) Other causes	10 ,,	
(4) A pyogenic cause present	4 ,,	
C.—Cases where no malarial parasite could be found in the blood, and only the following pathological condition could be discovered		29
Bronchitis	7 cases	
Whooping Cough	5 ,,	
Other cases	10 ,,	
Pyogenic	7 ,,	

INCOMPLETED CASES

When the clinical history was very incomplete and the child not kept under observation. None of these cases were suspicious		6

DOUBTFUL CASES

Case of fever with teething and convulsions	1	3
Pyrexia of uncertain origin	2	
		131

TABLE IV

LIST OF CASES OF DOUBTFUL NATURE AMONG ADULTS

Some 30 cases have been omitted, as of little or no interest, such as continued fevers associated with eosinophilia in out-patients. A series of cases of gastritis, practically apyrexial, &c. Faecal examinations and serum tests when negative have been omitted.

L.M. = Large mononuclear blood cells. P.M. = Probably malaria. P.U.O. = Pyrexia of uncertain origin.

No.	Where recorded	Race	Duration of fever	Highest temperature	Vomiting	Jaundice	Conjunctival injection	Faget's sign	Haemorrhages	Blood examination	Urine	Remarks
			Days									
1	Vol. I (18) (white form)	E.	4	101·4°	Yes, once, clear	No	No	No	No	2 examinations negative to malaria. L.M. 27%	No albumen	Blood examined after quinine taken. P.M.
2	Vol. I (51)	E.	4	103°	Yes, clear	No	No	No	No	1 examination negative to malaria. L.M. 10%	No albumen	P.U.O. Rigor, &c., yielded rapidly to quinine
3	Vol. I (53)	E.	2	101°	Once or twice, clear	No	—	No	No	1 examination negative (after quinine). L.M. 21%	No albumen	P.M. Rigors yielded at once to quinine
4	Vol. I (56)	W.A.	1	102°	No	No	No	—	No	Negative to malaria (once)	No albumen	Rigor sweating. P.M.
5	Vol. I (58)	E.	2	102°	No	No	—	No	No	Negative to malaria (but quinine taken). L.M. 8%	No albumen	Admitted twice for malaria
6	Vol. I (64)	E.	2	102°	No	No	No	—	No	Negative to malaria (quinine taken). L.M. 11%	No albumen	P.M.
7	Vol. I (75)	E.	2	100°	No	No	—	—	No	2 examinations negative to malaria (but much quinine taken). L.M. 15%	—	Had most of attack before admission to hospital. P.M. Admitted twice for malaria
8	Vol. I (74)	E.	2	100°	Yes, clear	No	—	No	No	1 examination negative to malaria (but quinine taken)	—	Had attack of proved malaria fortnight before. P.M.

TABLE IV—*continued*

L.M. = Large mononuclear blood cells. P.M. = Probably malaria. P.U.O. = Pyrexia of uncertain origin.

No.	Where recorded	Race	Duration of fever	Highest temperature	Vomiting	Jaundice	Conjunctiva. injection	Faget's sign	Haemorrhages	Blood examination	Urine	Remarks
9	Vol. I (83)	E.	Days 2	101°	No	No	—	—	No	1 examination negative. L.M. 15%	—	P.M.
10	Vol. I (81)	W.A.	8	103·6°	No	No	No	No, but typhoid-like	No	2 examinations negative to malaria, &c. Widal's reaction, negative	No albumen (3 times)	Probably typhoid, clinically typhoid
11	Vol. I (91)	W.A.	2	100·6°	No	Yes	No	Slow pulse	No	Negative to malaria, &c.	No albumen	Clay-coloured stools. Probably catarrhal jaundice
12	Vol. I (148)	E.	3	101·6°	No	No	No	—	In stools	2 examinations negative to malaria. L.M. 12%	—	Contracted syphilis 2 months before
13	Vol. I (150)	W.I.	5	104°	Yes, clear	No	—	—	No	1 examination negative to malaria	—	Clinically typical malaria. P.M.
14	Vol. I (160)	E.	1	101·4°	No	No	No	No	No	2 examinations negative to malaria (but large amounts of quinine taken). L.M. 16%	No albumen	Blood examination defeated by quinine. P.M.
15	Vol. I (188)	E.	1	99·6°	No	No	No	—	No	1 examination negative to malaria. L.M. 19%	—	P.M. from diff. count
16	Vol. I (213)	E.	2	99·6°	No	No	—	—	No	1 examination negative to malaria. L.M. 15%	—	P.M. from diff. count
17	Vol. I (243)	W.I.	2	103·4°	No	No	—	—	No	1 examination negative to malaria	—	Clinically typical malaria
18	Vol. I (257)	W.I.	4	104°	Yes, clear	No	—	—	No	1 examination negative to malaria	—	Clinically typical malaria
19	Vol. I (260)	E.	2	99·6°	Once, clear	No	Doubtful	No	No	2 examinations negative to malaria	—	13 stools a day. Clinically diarrhoea, gastro-enteritis

TABLE IV—*continued*

L.M. = Large mononuclear blood cells. P.M. = Probably malaria. P.U.O. = Pyrexia of uncertain origin.

No.	Where recorded	Race	Duration of fever	Highest temperature	Vomiting	Jaundice	Conjunctival injection	Faget's sign	Haemorrhages	Blood examination	Urine	Remarks
20	Vol. I (278)	E.	Days 4	101°	No	No	—	No	No	Negative to malaria	No albumen	Pyrexia with diarrhoea
21	Vol. I (280)	E.	3	101°	No	No	—	No	No	3 examinations negative to malaria	No albumen	Pyrexia with diarrhoea. Had blackwater on voyage home
22	Vol. II (3)	E.	5	104·2°	Yes, clear	No	—	—	No	3 examinations all negative to malaria parasites, but shows 15% L.M.	No albumen	Blood examinations made when T. normal and much quinine had been given. Case improved at once under quinine. Clinically malaria
23	Vol. II (6)	E.	4	102°	Yes, much, clear	No	No	—	No	No malaria parasites seen on 3 occasions (but quinine had been taken). L.M. 21%	No albumen	Marked diarrhoea. Patient has suffered much from malaria
24	Vol. II (7)	E.	5	103·4°	Yes, much, clear	No	No	—	No	No malaria parasites seen in 3 examinations (but quinine had been taken). L.M. 22%	No albumen	Diarrhoea and vomiting. intermitting temperature
25	Vol. II (27)	W.I.	4	102·4°	No	No	—	—	No	No malaria parasites found (but quinine already taken). Diff. count shows 9% eosinophils	—	Ankylostome ova in faeces
26	Vol. II (29)	E.	2	101°	Yes, clear	No	No	—	No	No malaria parasites found in 2 examinations (though no quinine taken)	No albumen	Diarrhoea and vomiting. Rigor, backache. P.U.O.
27	Vol. II (30)	E.	1 +	99°	Nausea	No	—	—	No	No malaria parasites found, but L.M. 20%	—	A day or two's fever illness before admission. Case of alcohol, I think. Several similar cases

TABLE IV—*continued*

L.M. = Large mononuclear blood cells. P.M. = Probably malaria. P.U.O. = Pyrexia of uncertain origin.

No.	Where recorded	Race	Duration of fever	Highest temperature	Vomiting	Jaundice	Conjunctival injection	Faget's sign	Haemorrhages	Blood examination	Urine	Remarks
28	Vol. II (31)	W.I.	Days 2	101°	Once, clear	No	No	No	No	No malaria parasites. L.M. 17%	No albumen	Case cleared up at once with quinine. No eosinophilia
29	Vol. II (35)	W.A.	1	102°	No	No	—	No	No	Negative to malaria. L.M. 5%	—	No eosinophilia. Clinically malaria
30	Vol. II (38)	E.	2	100°	No	No	No	No	No	2 examinations negative to malaria. L.M. 15%	—	Diarrhoea. Much bitten by mosquitoes which infested house
31	Vol. II (47)	E.	1	100°	No	No	—	—	No	2 examinations negative to malaria (before quinine taken). L.M. 22%, which dropped 1 month later to 16%	No albumen	Diarrhoea at first, very frequent
32	Vol. II (50)	E.	1	103°	No	No	—	—	No	Negative to malaria (but quinine taken). L.M. 17%	—	Clinically malaria. P.U.O.
33	Vol. II (52)	E.	3	102°	Yes, bile	No	Yes	—	No	2 examinations negative to malaria. L.M. 9%	No albumen	Severe diarrhoea. Case looked like sand-fly fever clinically
34	Vol. II (53)	E.	3	101°	No	No	—	—	No	2 examinations negative to malaria (but quinine taken). L.M. 18%	—	Diarrhoea, and fever which clinically resembled malaria
35	Vol. II (59)	E.	6	102·4°	No	No	No	—	No	3 examinations negative to malaria (but quinine already taken). L.M. 12% to 17%	No albumen	Diarrhoea present. P.U.O.
36	Vol. II (58)	E.	3	100°	No	No	No	No	No	3 examinations negative to malaria (but quinine taken)	No albumen	Had malaria before and after. Diarrhoea, prominent feature

TABLE IV—*continued*

L.M. = Large mononuclear blood cells. P.M. = Probably malaria. P.U.O. = Pyrexia of uncertain origin.

No.	Where recorded	Race	Duration of fever	Highest temperature	Vomiting	Jaundice	Conjunctival injection	Faget's sign	Haemorrhages	Blood examination	Urine	Remarks
37	Vol. II (73)	W.I.	Days 4	103°	No	No	No	—	No	Negative to malaria. Diff. count shows L.M. 14%	—	Fever clinically like malaria, and came down at once with quinine. P.U.O.
38	Vol. II (77)	E.	Attack and relapse 3 days each	104°	No	No	No	No	No	5 examinations negative to malaria, but L.M. cells rose by degrees from 6 to 18% and then came down to 12%	No albumen	Clinically typical malaria, relapse typical tertian intermittent
39	Vol. II (83)	E.	3	100° in hospital	No	No	No	—	No	2 examinations negative to malaria parasites. Diff. count shows L.M. cells 15%	No albumen	Clinically rigors and other signs of malaria before admission
40	Vol. II (100)	E.	5	102·4°	No	No	No	No	No	3 examinations negative to malaria, but quinine taken. L.M. cells rose from 11 to 15%. Agglutination tests negative	No albumen	
41	Vol. II (101)	E.	4	101°	No	No	No	No	No	3 examinations negative to malaria. L.M. cells were over 8%. All agglutination tests negative	No albumen	Clinically suspicions of rheumatism, and had a second attack a month later, diagnosed rheumatism on way to England
42	Vol. II (123)	E.	4	103·2°	No	No	No	—	No	5 examinations negative to malaria. L.M. rose from 6% to 12%, and then down to 8%	No albumen	Clinically fever resembles tertian malaria, severe diarrhoea throughout
43	Vol. II (134)	E.	5	102°	No	No	No	—	No	5 examinations negative to malaria. L.M. cells were over 6%. All agglutination tests negative	No albumen	Clinically unlike malaria P.U.O.

TABLE IV—*continued*

L.M. = Large mononuclear blood cells. P.M. = Probably malaria. P.U.O. = Pyrexia of uncertain origin.

No.	Where recorded	Race	Duration of fever	Highest temperature	Vomiting	Jaundice	Conjunctival injection	Faget's sign	Haemorrhages	Blood examination	Urine	Remarks
44	Vol. II (143)	W.I.	Days 9	104°	Once, clear	No	No	No	Yes (bowel) once	Negative to malaria. L.M. 10%	No albumen	Severe and persistent diarrhoea, slight blood in stools one day
45	Vol. II (163)	W.I.	4	104°	No	No	—	No	No	3 examinations negative to malaria. L.M. cells rose from 4% to 22%, and dropped again to 5%	No albumen	No eosinophilia
46	Vol. II (202)	W.I.	1	101·4°	Yes, once, clear	No	No	—	No	3 examinations negative to malaria. 17% to 24% of L.M. cells	No albumen	Blood picture looks like malaria
47	Vol. II (81)	W.A.	1	104°	No	No	No	—	No	Blood negative to malaria. 7% L.M.	—	Clinically like malaria
48	Vol. II (212)	W.I.	1	102·2°	No	No	—	—	No	2 examinations negative to malaria, but L.M. from 20% to 30%	—	Clinically like malaria, four previous attacks of proved malaria in 1 year
49	Vol. II (226)	E.	3	100·6°	No	No	No	No	No	3 examinations negative to malaria. Wassermann positive	No albumen	? Syphilis
50	Vol. II (249)	W.A.	2	102·6°	No	No	—	—	No	1 examination negative to malaria. L.M. cells 8%	—	3 days' diarrhoea, cause unknown, faecal exam. negative
51	Vol. II (250)	W.A.	2	99·2°	No	No	—	—	No	1 examination negative to malaria. L.M. cells 12%	—	3 days' diarrhoea, cause unknown, faecal exam. negative
52	Vol. III (64)	W.A.	5	101°	No	No	No	No	No	1 examination negative to malaria. L.M. cells 12%	—	A week's diarrhoea, cause unknown, faecal exam. negative
53	Vol. III (65)	W.A.	2	99·4°	No	No	—	—	Yes, in stool	Negative to malaria	—	2 days' diarrhoea, faeces show *Entamoeba coli* only

TABLE IV—*continued*

L.M. = Large mononuclear blood cells. P.M. = Probably malaria. P.U.O. = Pyrexia of uncertain origin.

No.	Where recorded	Race	Duration of fever	Highest temperature	Vomiting	Jaundice	Conjunctival injection	Faget's sign	Haemorrhages	Blood examination	Urine	Remarks
54	Vol. III (72)	W.A.	Days 2	100·4°	No	No	—	No	No	Negative to malaria. L.M. cells 16%	No albumen	Tender gall bladder. P.U.O.
55	Vol. III (74)	W.A.	2	101·8°	No	No	—	No	No	Negative to malaria. L.M. cells only 4%	—	Severe constipation, purgatives relieved fever
56	Vol. III (81)	W.A.	2	102°	Yes, clear	No	—	—	No	No malaria. *Filaria* present. L.M. cells rose from 4% to 11%	—	Diarrhoea present 1 day, rigor
57	Vol. III (98)	W.A.	2	103·4°	No	No	—	No	No	Negative to malaria, &c. L.M. cells 3%	No albumen	Obstinate constipation rigors
58	Vol. III (134)	W.A.	2, the relapse of 1	103°	No	No	—	No	No	Negative to malaria, &c. L.M. cells 8%	—	T. chart like malaria
59	Vol. III (207)	E.	1 day followed by relapse of 1 day	102°	No	No	No	—	No	Negative to malaria, &c.	—	T. chart like tertian, malaria, rigors, sweating, &c.
60	Vol. III (223)	W.A.	1	103°	No	No	—	No	No	Negative to malaria, &c. L.M. cells 6%	—	1 day's fever only
61	Vol. III (235)	E.	3	101·4°	No	No	—	No	No	No malaria, but quinine taken. L.M. cells 7%	—	Rigor, sweating, &c., clinically malaria
62	Vol. III (236)	E.	3	101°	No	No	Yes ?	—	No	No malaria, &c. Eosinophils 11%. L.M. 10%	—	Throat sore
63	Vol. III	W.A.	About 14	About 103°	No	No	—	Typhoid pulse	No	Negative to malaria, &c. Widal's reaction, positive to typhoid	No albumen	Clinically typhoid, a typical bacillus isolated from blood

TABLE IV—*continued*

L.M. = Large mononuclear blood cells. P.M. = Probably malaria. P.U.O. = Pyrexia of uncertain origin.

No.	Where recorded	Race	Duration of fever	Highest temperature	Vomiting	Jaundice	Conjunctival injection	Faget's sign	Haemorrhages	Blood examination	Urine	Remarks
			Days									
64	Vol. IV (28)	W.A.	A week	99°	No	Yes	No	—	No	2 examinations negative to malaria, &c. L.M. 6%	No albumen	Clay-coloured stools, catarrhal jaundice (?)
65	Vol. IV (34)	E.	3	101·4°	Yes, clear	No	No	No	No	2 examinations negative to malaria, &c., but quinine taken. L.M. cells rose from 4% to 12%	No albumen	P.M.
66	Vol. IV (8)	E.	3	99·6°	Yes, bile	No	No	No	No	3 examinations all negative to malaria. L.M. cells 6% to 7%	No albumen	P.U.O.
67	Vol. IV (11)	W.A.	1	103°	No	No	—	—	No	Negative to malaria, &c., slight leucocytosis. L.M. cells 8%	—	Clinically malaria
68	Vol. IV (36)	W.A.	14	101·2°	No	No	—	—	No	2 examinations negative to malaria. L.M. cells 7%. Widal's reaction, negative	—	Headache only symptom, P.U.O., faeces negative
69	Vol. V (58)	W.A. child 5 yrs.	12	104°	No	No	No	No	No	5 blood examinations negative to malaria, leishmaniasis, &c.	No albumen	Large spleen and liver, leucopenia: ? Leishmaniasis. Liver puncture yielded Koch's granular bodies (2 or 3 only)
70	Vol. V (67)	W.A. baby	4 in hospital 7 out	102°	No	No	No	No	No	3 blood examinations negative to malaria and Leishman-Donovan bodies. L.M. cells 30% to 35%	No albumen	Liver and spleen slightly enlarged. P.U.O.
71	Vol. V (99)	E.	7	102·6°	No	No	No	No	No	2 examinations negative to malaria, &c.	Slight cloud of albumen	P. had 3 distinct and different kinds of rashes. ? Typhus, dengue type

TABLE V

Table of race incidence of fevers.

Races	Volumes of Records						Totals
	Vol. I	Vol. II	Vol. III	Vol. IV	Vol. V	Children's Vol.	
European ...	86	82	78	16	8	—	270
Syrian	—	—	—	—	17	4	21
West Indian ...	176	155	127	20	3	2	483
West African ...	20	22	42	29	74	125	312
Totals ...	282	259	247	65	102	131	1,086
	Military cases				Civilian adults	Children	

TABLE VI

Showing race ratio of admissions to the hospital, per 1,000 of strength, for malarial fever, for 1908-1913

Year	European officers		European men		West Indian soldiers		West African soldiers	
	Strength	Sick rate	Strength	Sick rate	Strength	Sick rate	Strength	Sick rate
1908	80	762·5	258	906·8	520	471·1	1482	52·0
1909	76	460·5	268	652·0	543	714·5	1484	43·8
1910	80	825·0	276	1032·6	504	573·4	1440	22·2
1911	84	702·4	290	686·2	479	507·3	1422	52·0
1912	86	941·9	303	567·6	520	807·7	1432	53·1
1913	—	964	—	462	—	765	—	60

N.B.—The strengths for 1913 are much the same as in 1912.

VI. *Notes on Tables*

Notes on Table I—(cases of adults)

In all the tables of diseases, those cases which were so insufficiently investigated as to be worthless, are omitted from the disease series, and placed in a special group of incompleted cases. No case in the slightest degree suspicious of any type of yellow fever, however, was placed in this group even if it had not been properly investigated. Such cases are classed among those labelled 'doubtful.'

Of the completed cases 676 out of 818 fevers in adults, or 83 per cent., were due to malaria, and caused by the subtertian type of parasite in all but a few cases. As this question and that of blackwater are more fully discussed under the heading of Malaria, it will not be further pursued here.

The other cases call for little comment. Two were cases of trypanosomiasis, and there was one proved case of typhoid.

The number of cases of ankylostome fever (22) does not represent the widespread nature of the affection, for only the severe cases come to hospital.

There are 11 cases marked gastritis in this table. These were from among Europeans, and were practically apyrexial. They were investigated because of the stomach symptoms, but there was nothing suspicious about these cases, which were largely due to oversatisfied thirst.

The other cases include those of lung trouble, syphilis, rheumatism, &c. It is extraordinary how few such cases there are, when it is remembered that this table includes practically all the medical pyrexias which occurred. The five cases of jaundice were, in my opinion, catarrhal in origin.

Notes on Table II

This table has been very difficult to compile. The group into which these diseases have been placed is purely arbitrary. But this grouping was submitted to an independent observer, who altered it but little.

These cases have not only been all recorded in the volumes of cases, but also copied out on white forms and sent to the Commission, and these records can be examined.

It is a remarkable fact that the number of 'doubtful' cases

steadily diminished late in the period of the investigation when the blood examinations became more frequent and prolonged, the number of malaria cases increasing correspondingly.

The two groups (1) Malaria, probably, on clinical and bacteriological grounds; and (2) Malaria (?) on clinical grounds only; represent cases which were diagnosed malaria by the medical officers in charge of them.

Each case has been closely examined, and placed in these groups owing to its blood picture and symptom complex.

In most of these cases either quinine had been administered before blood examinations, or only one slide was examined.

Of course, the difficulty of considering a case of malaria from a high large-mononuclear count alone is obvious in a malarious country, where previous malarial attacks may have altered the blood picture.

A detailed record of these cases has been before the Commission, and is found in Table IV, but more briefly detailed.

The group of cases (3) called Enteritis with pyrexia (?) had diarrhoea as a prominent symptom, and in most cases would have ordinarily been diagnosed as such. The etiology of such cases is interesting, and so far unsolved. Pathogenic amoebae or other protozoa have not been seen in the stools, and in two of the severer cases dysentery bacteria were examined for, but not isolated.

The Ankylostomiasis (?) group in these cases came from West African out-patients; cases of slight prolonged fever, associated with eosinophilia. The cases could not be followed up or stool examinations made.

The Kala-Azar (?) group was also from among West African out-patients, with large spleens and leucopenia. These cases also could not be followed up. A large number of doubtful cases come from the West African out-patients. These cases, though interesting, are in no way 'suspicious.' It is fortunate that the great bulk of my cases, about 900, came from hospital patients, as such patients can be kept under observation.

The group of cases named Pyrexia of uncertain origin includes those which were impossible to diagnose definitely. It is noteworthy, however, that 11 of the 14 cases occurred in the period before the yellow fever investigation started or just after it had started. When blood examinations became more careful such cases diminished markedly in number.

Notes on Table III—(The children's cases)

The grouping of the cases among children was rendered difficult owing to the presence of malaria parasites in the blood of two-thirds of all Sierra Leone children. The three divisions of the disease into (*a*) cases where malaria alone was present; (*b*) cases where malaria and some other disease was present; and (*c*) cases of disease where malaria was not found, may be clumsy, but is practical.

Although the majority of children have malaria parasites in their blood even when apparently well, this does not show that they do not get malarial fever, and on these fever days are ill at home or suffer from fever at work or play.

Those fever cases where blood examination showed the malaria parasites to be very numerous might be considered as malarial in origin, but a number of fever cases due to malaria might not show high blood infection at the time they were examined.

The diseases of children who were in-patients were more readily diagnosed; it was the little out-patients that gave all the trouble. The group of 33 cases in the table shewn as malarial fever has been carefully compiled from the clinical as well as the pathological side, and doubtful and incomplete cases were eliminated as far as possible.

The second and third groups need little mention. The group of 60 cases of malaria and some other disease had sufficient of that other disease to cause fever, and this remark applies equally well to the third group of the three doubtful cases; only one case, that of fever in a Syrian child, was in any way 'suspicious.'

Notes on Table IV

This table briefly describes 72 of the doubtful cases.

In those cases where blood examination was negative to malaria, it may be understood that it was negative to other blood parasites.

Faecal examinations have not been mentioned, though often carried out, and for want of space only the more important symptoms have been mentioned. These 72 cases and some others are detailed more fully on the white forms and in the volumes of records.

Notes on Tables V and VI

The race incidence of fevers and the table showing race ratio of admissions for malaria show on paper how very much more the European and the West Indian suffer from fever than the African.

There is little to choose between the European and West Indian fever rate; but the West African has but one-tenth of their fever sick rate.

Although this difference is a real one, it is probably not so great as appears in these tables, owing to the habit of the West African, generally a married man, of not reporting sick with fever, this fever, if malaria, being generally of a mild type owing to racial immunity.

VII. *Controls*

Blood examinations. The blood of over 30 *Europeans*, either healthy men or those in hospital for surgical and other complaints, was examined for malaria. Malaria parasites were not found present in any case.

In the blood of some 25 West Indian soldiers doing their work, malaria parasites were found in one case. Temperature 99°. One of my predecessors examined 170 duty men of the regiment some years ago, and found 6 per cent. of them to have malaria parasites in their blood. It is possible that some of these men were feeling ill, but not sufficiently so to report sick.

No malaria parasites were found in the blood of 150 African soldiers on two occasions, but the search was somewhat casual, as trypanosomes were the chief object of my search.

Urines.

Europeans. No cases of albuminuria in 20 healthy men.
West Indians. }
West Africans. } In some 30 cases examined slight albumen, but no casts, present in 7.

Faeces.

No ankylostome ova found in stools of any healthy Europeans.

Some 40 per cent. of all West African and about two-thirds of all West Indian soldiers had these ova in their stools.

VIII. *Notes on the various Diseases met with*

These notes have been incorporated, with very minor additions, from my annual sanitary report on Sierra Leone for 1913. I have not had an opportunity to elaborate these rough notes.

Malaria. Of the total of 851 adult cases investigated, 67·6 per cent., or roughly two-thirds, have been proved microscopically to be malarial in origin. These figures are sufficient to show the overwhelming preponderance of this disease on the West Coast of Africa, and these figures are supported by a collateral investigation carried out among the civil population, where the percentage of sick native children suffering from malaria was higher still, 80 per cent., and a malaria census of apparently healthy native children, carried out by Major Morris, R.A.M.C., in 1906, showed about two-thirds of them to harbour malaria parasites in their blood.

Type of parasite present. The type of parasite found in these 676 adult cases of malaria was the subtertian in all but 10 instances. The absence, practically speaking, of quartan and benign tertian affections in these adult cases is curious, inasmuch as the proportion of these parasites found in the blood of a hundred sick native children suffering from malaria amounted to as much as 20 of the total. It is not difficult to understand why the adult African soldier should be free from quartan and benign tertian malarial infection, as it may be assumed that immunity is more readily acquired against these less virulent types of parasites. The similar freedom of the West Indian soldier from such malarial infections may be due to an immunity acquired in Jamaica. I do not see, however, why the European soldier so rarely suffers from quartan or benign tertian malaria, for he can have no such immunity, unless, owing to segregation, the source of his malaria is the adult native, and not the child. It is possible that the sub-tertian parasite of West Africa is somewhat different from that found in Asia, for the following reasons:—

1. The gamete ('crescent') forms are more rarely found than in other countries. Out of 176 cases of malaria, one of my predecessors found only 6 cases where crescents were present in the blood, although they were specially looked for. In the series of cases under review, the proportion is still smaller, but no special search was made for these sexual forms. In the blood of 100 malarial children, crescents were found in 5 of the cases.

2. The great difficulty occasionally met with in finding parasites in cases which are clinically typical malarias. This difficulty is comprehensible when the immune West African is in question, but

in a West Indian or European soldier, this difficulty is also often encountered, and the parasite is only found after hours, or even days, of searching, though no quinine may have been taken, and periodicity allowed for. I have had similar difficulty with subtertian malaria in South Africa, but cannot remember such cases in India. This difficulty of demonstrating the parasite in some cases may account for some of the cases in the group labelled 'probable malaria' in Table II, though it has to be admitted that in the majority of these cases only one blood examination was carried out. It may also account for some of the cases in the 'pyrexia with enteritis' group and in the 'P.U.O.' group, where some of the clinical symptoms pointed to malaria, but no parasites could be found.

3. The third reason for supposing that in West Africa we may be dealing with a different 'race' of subtertian parasites, is its amenability to quinine. There is a feeling among those of us on the coast who have treated subtertian malarias acquired in other parts of Africa and India, that this type of West Coast malaria is more amenable to quinine.

Clinical Nature of Malarial Attacks. It is comparatively easy to distinguish between the temperature charts of (*a*) the West African soldier, and (*b*) the West Indian soldier, and (*c*) the European soldier. The febrile curve differs in each of the three cases. In the West African, as a rule, the fever is very short, lasting but one or two days; this is, of course, due to his immunity.

The West Indian, on the other hand, reacts to malaria with high temperatures, accompanied usually by marked remissions and intermissions. He appears to suffer more severely from malaria than the European soldier.

Jaundice was present in but few cases (several bilious remittent fever).

Vomiting frequently occurred, but was never red or black. Bile was occasionally present.

Faget's sign was not noted in any case.

The urine of 30 per cent. of the native malarial cases contained albumen, but as it occurred in only 5 to 10 per cent. of the European cases, this may have been due to other causes.

Relapses of malarial fever have been frequent among the West Indian soldiers, but unusual in the cases of European troops.

Bilious Remittent Fever. Jaundice, unless looked for, may easily be missed in the West African and West Indian, owing to the chronic conjunctivitis and pterygium condition which they suffer from, but I am inclined to believe that typical bilious remittent fever is uncommon among the troops.

I have personally seen some half-a-dozen cases only, where jaundice (slight in all cases but one) was present. Bilious vomiting is more frequently seen. The one case of malaria with marked jaundice died. In this case, which occurred in an alcoholic, besides a very heavy subtertian malarial infection, a large fatty and cirrhosed liver was found. This case was peculiarly instructive, because: (1) The clinical features simulated those of yellow fever, and (2) it is probable that the heavy mortality caused by malaria in earlier years at Sierra Leone, when the troops were not as temperate as they are now, was due to similar conditions, i.e., malarial infection occurring in men whose resistance had been greatly lowered by cirrhosis of the liver due to alcohol.

Malarial Incidence. Taking one year with another, the percentage of malarial attacks is at least five times as great amongst the European troops living on the Wilberforce ridge, as amongst those at Tower Hill. This year the figures are :—

Station	Period	Average Strength	Admissions
Tower Hill (*Anopheles*-free)	Jan. to Sept., 1913	158	43
Posts on Wilberforce Ridge, surrounded by bush and near native dwellings	Jan. to Sept., 1913	23	46

This probably much understates the true proportion in favour of the Wilberforce ridge, for soldiers on outpost duty do not report sick, as a rule, if the attack of fever is light or transient.

Blackwater. This term probably covers a group of pathological conditions which might with advantage be differentiated, and the term 'Blackwater fever' limited to the cases which are not obviously haemoglobinuria due to drugs such as quinine, or the severe blood destruction in intense malarial infections. Among the seven cases of haemoglobinuria I have come across out here during

the last twelve months, one was a native child, probably a malarial haemoglobinuria. The malarial infection in this case was intense, the blood destruction very great, and the haemoglobinuria transitory. Of the cases among the troops, four in number, one case might also, I think, be considered one of malarial haemoglobinuria, for here, too, the infection was a heavy one, and the haemoglobinuria transient. In two others of the military cases the haemoglobinuria was due to drugs. In the first case, that of a West India Sergeant's son suffering from malaria, it followed soon after the administration of a strong dose of camphor and gin. The haemoglobinuria was very transitory, and the urine strongly aromatic in odour. In the second case the blackwater was closely associated with the taking of quinine, appearing soon after its exhibition, on two separate occasions. No malaria parasites were found in this man's blood, when the quinine had been taken, and the haemoglobinuria developed, but the patient had suffered from a very severe subtertian infection only a month before. In the fourth military case there was a very slight transient haemoglobinuria in a patient who had suffered frequently from malaria, and in whose blood subtertian parasites had been found only two days before. A fifth case of haemoglobinuria amongst the troops occurred in a time-expired man who had suffered from only one attack of fever, in Sierra Leone, three months before, which had been diagnosed 'P.U.O.,' as no malaria parasites could be detected. This man was detained a day in hospital with fever, before embarkation, but there is no record of a blood examination having been made, and he was in hospital on board, from his embarkation onwards. There was no blood film taken from this man, as there were no slides on board. Lieut.-Col. Gerrard, who was in charge of the case, very kindly sent in the temperature chart and some notes on this case. This case is not included in my tables. Two cases of moderately severe blackwater occurred amongst European civilians, and though not included in my tables, are noted in a separate volume of records.

I found what I considered to be 'cell inclusions' in one of the series of the seven blackwater cases.

Trypanosomiasis. Two cases of this disease have been found among the troops, both occurring in soldiers of the West African

regiment. One case was found in December, 1912, and the second case in June, 1913. Since the discovery of the first case some three hundred or more blood smears, and eleven gland punctures from West African soldiers have been examined, with only one positive case, the one found last June. Major Grattan, R.A.M.C., when S.S.O. in 1906, found eighteen cases altogether, in a search conducted in Freetown and the Protectorate. Two of these cases were from the troops. Several of these cases were followed up in subsequent years, and some of them had developed 'sleeping sickness' and died.

Leishmaniasis. No cases of infection by *Leishmania* have been found amongst the troops. In two native civilian cases, I have found what may have been Leishman-Donovan bodies in large mononuclear blood cells, but as only one body was found in each case, nothing further can be said about them, except that the spleens in these patients were greatly enlarged and leucopenia was present in both. A number of dogs were examined for the presence of *Leishmania infantum*, but with negative results. Large spleens are not infrequent in native children, as might be expected in a malarious country like this. Enlarged livers are less frequently found. In one case of Dr. Butler's, a child with pyrexia and an enlarged liver and spleen, we discovered in the liver juice curious bodies superficially resembling Koch's granules of East Coast fever, present in numbers. In a second case, similar to this clinically, I found one or two similar bodies in two slides of liver juice which were examined. The nature of these bodies, which were submitted to Sir W. Leishman, is undetermined, but a preliminary report of them was published in the Journal of the Royal Army Medical Corps, Vol. XXI, No. 6, December, 1913.

Pappataci, Dengue, Three-day Fever, and Seven-day Fever. There have been some seventy cases of undiagnosed fever, where no malaria parasites have been found in the blood. Some of these cases have been so incompletely investigated from a clinical and laboratory standpoint, that they cannot be satisfactorily discussed. The majority of the remaining cases were, I think, from clinical and bacteriological grounds, cases of malaria, where the parasites had been missed, either owing to a single blood examination only having been made, or to the great scarcity of parasites, a condition which

one so often notices in subtertian malarial infection out here. There remain other cases where the most complete search on successive days failed to reveal malaria parasites, and some of these cases may have belonged to the group of diseases mentioned above.

The sporadic rather than epidemic nature of these cases, and the absence of rashes, conjunctival injection, and joint affections, appears to negative pappataci fever, or dengue in the epidemic form, but some of the cases may have been of the nature of sporadic dengue, or seven-days' fever, if these are clinical entities. Amongst the group of undiagnosed cases have been several with definite gastro-intestinal symptoms. I would prefer to defer any opinion on this group of cases, until I have had more time to study them. Though *Simulidae* and *Chironomidae* abound in Sierra Leone, I have never met with, nor heard of the *Phlebotomus papatasii.*

Yellow Fever. This disease appears in such protean forms in mild cases that it seems impossible to say that it has not been met with and remained unrecognised. The only case with clinical features at all resembling yellow fever was that mentioned above under 'Bilious Remittent Fever' (page 379), in whose blood and organs large numbers of subtertian parasites were found.* This was considered to be a case of bilious remittent malaria, with cerebral symptoms and complicated with cirrhosis of the liver.

Jaundice. There have been five cases diagnosed jaundice during the twelve months. Of these, one was contracted on board ship, and was obviously catarrhal. A second was under my own care, and was in my opinion obstructive. The remaining three occurred within a fortnight of each other; there was practically no pyrexia with any of these cases, and vomiting occurred in one only, and then after taking food on two occasions. There is no reason to suppose that these cases were other than catarrhal jaundice.

Typhoid and Paratyphoid Fevers. There has been one case of typhoid fever where the typhoid bacillus was isolated from the urine, and where marked agglutination reactions against *Bacillus typhosus* were obtained. As the patient was a sailor on a German cruiser, it is not certain that the case was contracted on the Coast. There have been two cases among West African soldiers, with typhoid symptoms.

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* Further details of this case are given on page 385 *infra.*

Blood cultures were made in both cases, but as the culture flasks had to be carried along a rough road for a long distance, and were much shaken up, pure cultures were not obtained in either case. From both cases Gram negative, motile organisms, giving rise to the production of acid in lactose, and acid and gas in glucose, maltose, and sucrose, were obtained. In the first instance, the organism isolated did not agglutinate with the patient's serum; in the second instance, only to the extent of a one-twentieth dilution in one hour. Control negative. I am convinced, notwithstanding these results, that typhoid will be proved to exist amongst the West African natives, though probably only to a less extent than amongst the native Indians in India.

Undulant Fever. Though no case has yet been found where the blood reacted with the *Micrococcus melitensis* (and several have been tried), yet as goats abound in Freetown, and the milk is sometimes drunk by natives, I think undulant fever may be present in Sierra Leone.

Other Diseases. The small number of syphilitic cases, of course, does not represent the wide-spread nature of this disease among the West African troops. These men are probably highly immune to syphilis, and suffer little from its effects, and do not often 'go sick' with it.

The cases of tubercle, pneumonia, bronchitis, &c., need no comment; but with regard to the rheumatism cases, I consider in the light of the year's experience, that some of them may have been cases of ankylostome fever.

IX. *Problems before the Commission*

The series of questions put to investigators are briefly answered as far as possible.

The fevers known to occur among Europeans, other non-natives and natives.

These have been enumerated in the tables, and the only points to be noted are (1) That typhoid is probably more prevalent among all these classes than at present supposed.

Leishmaniasis is, in my opinion, also present, if rare.

Do the following diseases occur in West Africa?

Of this list typhoid and paratyphoid do occur. The presence of the other diseases, viz., dengue, pappataci, typhus, Rocky Mountain fever, double continued, undulant and para-undulant, has not been proved.

The nature of the fevers which have been termed—

(*a*) Bilious remittent fever.

(*b*) Malignant bilious remittent fever.

I personally consider that malaria can produce these types of fever, i.e., a remitting fever often severe, with jaundice and bilious vomiting. This type of fever is more likely to occur in persons with incompetent livers. I have seen a marked example of this condition, and such cases must have contributed to the high mortality which reigned on the Coast in the old hard-drinking days.

Three-day fever and seven-day fever have already been discussed under the headings of pappataci and dengue fever, in the notes on diseases.

I have not come across the terms febricula, low fever, inflammatory, endemial or acclimatising fever in Sierra Leone.

I heard of a case of hyperpyrexial fever in a child occurring while I was at Sierra Leone, but did not see the case.

May the high infant mortality rate among natives be attributed to any form of fever?

I understand that syphilis is prevalent in Sierra Leone, but I failed to see many cases of congenital syphilis among the children attending the Missionary hospital I worked at. In fact, these cases were so few that it is difficult to believe that the high infant mortality rate of Sierra Leone can be due to syphilis, though this disease may account for the high percentages of miscarriages.

I was unable to consult any registers of births and deaths, and even had this been possible, no valuable results could have been obtained in this way, as so few deaths are registered. I frequently cross-questioned the women out-patients, and it was not unusual to find that they had lost half of the children born to them. When questioned as to the cause of death, they were vague in their answers. Fever, 'belly humbug' or diarrhoea and wasting, being often mentioned.

I think enteritis is more prevalent among native children than is generally suspected. To what extent the universal infection of native children with malaria affects the mortality rate it is impossible to say.

Symptoms of jaundice, vomiting and flushed eyes were usually enquired for; but these symptoms, though occurring, seemed rare, and I never elicited any history of epidemic child deaths.

As to there being any evidence that some infantile diseases confer immunity to yellow fever.

This cannot be answered for reasons given in answer to the preceding question.

As no case which I could recognize as yellow fever occurred during the period of my investigation in Sierra Leone, the remaining questions cannot be answered.

There was only one case, which for some hours I believed might be one of yellow fever. This case was one where there was a high remittent temperature, slow pulse, jaundice, congestion of the conjunctiva, and where after death the stomach contained brown fluid with black specks, the stomach mucosa being covered in places with small petechiae. The liver was enlarged—yellow, fatty, and cirrhotic. The blood both before and after death was crowded with subtertian malaria parasites, and these protozoa were present in great numbers in the various body organs. Section of the liver showed that organ to be extensively cirrhosed, while the liver cells were degenerated and fatty.

Microscopic examination of the kidney shewed it to be the seat of cell degeneration of the tubules, and the intestinal tissue was markedly increased.

Dr. Butler, who helped me with the post-mortem examination of this case, was even more certain than I was that we were dealing with a case of intense malarial infection in a patient handicapped with a diseased liver. This case was sent on to the Commission, fully detailed.

The nature of the virus of yellow fever.

As soon as the investigation started, plates showing the bodies described by Seidelin as occurring in yellow fever cases were care-

fully studied. I had Seidelin's illustrations of these bodies always at hand in the laboratory, and such bodies were looked for in the slides.

My experience of blood work is fairly wide, but I am unable to distinguish between some of the bodies illustrated in these plates and small malarial rings.

The majority of the bodies described and illustrated by Seidelin are, however, definite and individual enough, being chromatin dots with a margin of solid blue staining protoplasm.

During the examination of the two or three thousand blood slides from the recorded cases, it often happened that the condition known as *Anaplasma marginale* was found in the blood specimen; sometimes, too, very minute bodies, whose nature was difficult to decide on or describe, were seen. These minute bodies were not nearly so definite as those illustrated by Seidelin, but when drawn closely resembled them. I was, unfortunately, never able to reproduce these indefinite-looking little objects without making them look like protozoa in a drawing.

I have observed similar bodies for years in various blood specimens, and in various countries, and have always looked upon them as nuclear rests or possibly artefacts. In view of Seidelin's reports, however, these bodies when found were carefully studied.

Since returning to England I have had the opportunity of examining a number of slides of guinea-pig blood given me by my friend Major Harvey, R.A.M.C.

I have found these small bodies in slides from guinea-pigs 'inoculated with yellow fever blood,' and also in slides from normal guinea-pigs.

From my small experience of guinea-pig blood, I would be inclined to think that these minute bodies are more frequently found here than in human blood.

X. Conclusions

1. Malaria is the overwhelmingly predominant fever of Sierra Leone, accounting for over three-fourths of all fevers.

2. I have not been able to recognize a case of yellow fever as occurring during the period October, 1912, to October, 1913, when I was investigating fevers in Freetown.

It is quite possible that as the milder cases of the yellow fever may be clinically unrecognizable as such, and as there is no definite blood test, I may have overlooked such cases.

I cannot close this report without mentioning what I consider a very serious point in the psychology of the investigation of fever at Sierra Leone. Perhaps these remarks apply to other parts of West Africa as well.

There apparently has been a period on this Coast, according to Sir Rubert Boyce and other observers, when the diagnosis of yellow fever was unpopular, possibly a risky procedure. There is among many medical officers to-day serving on this Coast a feeling that the finding of yellow fever is expected of them, and cases of fever associated with transient albuminuria are considered highly suspicious of yellow fever. We know little of the fevers of the West Coast, and still less of their effects on the human kidney. As it is possible that the whole symptom complex of yellow fever may be supplied by a totally different, even fatal disease, it behoves all those who are investigating to keep clear of preconceived theories, and confine their energies to recording facts, and leaving the interpretation of these cases to the Commission at home.

Personally, I hold that it is of the greatest service to record all cases of fever of short duration, and I intend to continue doing so, paying more special attention to pulse rates and urine examination than I was enabled to in this series now under review.

REPORT ON WORK CARRIED OUT AT FREETOWN FROM MAY 1st TO SEPTEMBER 14th, 1913

BY

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Introductory

The following remarks have been put together at the request of the Yellow Fever Commission and form a general summary of the work undertaken in Sierra Leone.

My appointment as Local Investigator dates from May 1st, from which date also Major Statham, R.A.M.C., was appointed as the senior Investigator. It was particularly opportune that Major Statham could arrange to live in the same quarters with me, and this he continued to do for almost the whole time during which I was engaged in the investigation. Owing to this arrangement we had ample opportunity for discussing intimately any matters that arose in connection with our work, and throughout our relations have been particularly cordial. When Major Statham decided to retire from the work of the investigation in his official capacity, he continued to live with me and helped me in many matters, but there was a distinct loss in guidance, which owing to my inexperience was particularly necessary in this investigation, if a well-organised result was to be obtained.

I owe a great debt of gratitude to Major Statham for his help in the earlier work of the investigation, and I regret that I am unable to obtain his assistance in compiling this report, which therefore contains only my share of the work.

The Procedure of the Report

The outline to be followed in the report is here given briefly. An account of the preliminaries, the material available and the methods of dealing with it and classifying it for statistical purposes will be outlined, and then followed by an effort to deal with the problems, as scheduled in the 'Instructions to Investigators,' as far as I am able, considering the short duration of the enquiry.

Preliminaries

The work before us as Local Investigators was discussed by Major Statham and myself, as to the lines upon which it had better be conducted in order to obtain orderly results. Our first difficulty arose over the point as to what we should regard as a case of 'fever,' and it was decided that a patient showing a temperature of 100° F. should be considered a 'fever case,' unless at the time an obvious 'surgical' or septic cause could account for the condition. This was laid down only as a rough rule for guidance, and it will be seen in the report that patients who were ill or complained of being ill, but showed less fever than 100° F. have been occasionally included. In view of the fact that there might be a mild form of Yellow Fever or other fevers, we thought this ruling was justified.

Major Statham suggested that a meeting of the local practitioners of Freetown should be called, and Dr. Collett, the Acting Principal Medical Officer, was asked to arrange this for us. This meeting took place early in May, at Dr. Renner's house, and the following native medical men were present:—Drs. Renner, Easmon (Sen. and Junr.), Campbell, Taylor, Bright, Jarrett, Pratt, and Maxwell. Dr. Collett, Major Statham, and myself, were naturally present, but no other members of the West African Medical Staff.

At the meeting, Major Statham explained the reason why it was called, and made it obvious that help from the local practitioners would enhance the chances of a successful result, and asked for the co-operation of all those present. Major Statham proceeded to discuss the objects of the Commission and the nature of the problems before it, and in what ways the local medical men could help the work. A demonstration of the method of taking and making a blood film was given, and every member present was asked if he would help the Commission by taking blood films from his patients and forwarding them either to Major Statham or myself for examination, and in return we would make a report for them. Slides, 'Blue Cards,'* and forms explaining what was required by the Commission were presented to each. I myself told each individually that I was prepared to come and take films from their patients if that would be

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* *Vide* note on page 354 *supra*.

any help to them. The meeting was cordial, and gave encouragement to the view that we could rely on the help of the local practitioners.

The question of informing the members of the West African Medical Staff and other practitioners was not in our hands, and I am not aware to what extent they were asked to co-operate, or whether they were supplied with the necessary equipment for carrying out the making and staining of blood films. On two or three occasions I have given forms of instructions to members of the West African Medical Staff when I found they were unacquainted with them.

At my suggestion Dr. Collett endeavoured to communicate with all missionary and other medical practitioners in the Protectorate with the object of obtaining their help, and I sent home for glass slides for their use, but as I had no call for them I imagine Dr. Collett's efforts were not very successful.

The Investigation

The procedure and details of the Investigation will be alluded to under several distinct heads, thereby giving a clearer conception of the work and its difficulties.

The Laboratory. This is situated in the Colonial Hospital buildings, in a very small room and quite insufficiently equipped, except for general clinical pathological technique of the most elementary type. (This has been remedied since my period of investigation.) Owing to the size and equipment of the laboratory, it appeared to me to be impossible to have more than one officer working there at a time, and I therefore asked the Acting Principal Medical Officer if I might be allowed the sole use of the laboratory. This permission was granted me, and all my work in connection with the investigation was carried out there. With the co-operation of Major Statham it was possible to have the more complicated diagnostic processes carried out at the R.A.M.C. Laboratory attached to the garrison, and even after Major Statham's retirement he expressed his willingness to help me personally in all matters that I wished done. My thanks are due to Major Statham for this courtesy, and I availed myself of the offer on several occasions.

Fifty pounds was granted for preliminary expenses in connection with the investigation; a small portion of this was expended in obtaining extra supplies of glass slides, etc., and the balance was handed over to my successor.

The Material. The material which forms the basis of this report has been obtained from two separate and distinct sources—cases from the hospitals which have been investigated by myself, and those that have been sent by medical practitioners in Freetown and from the Protectorate. They will be alluded to under these two headings.

1. *Material sent by Medical Officers in Freetown and elsewhere.* This took the form of blood-films for examination, and blue case cards already completed. These are tabulated below, showing from whom they were obtained and the numbers so obtained.

(*a*) Blue Cards from—

Dr. Mayhew (Daru)	3
Dr. McConaghy (Bo)	1
Dr. Collett (Freetown)	1
	5

(*b*) Films for Examination—

Dr. Whitehead (Cline Town)	8
Dr. Easmon, Jun. (Freetown)	9
Dr. Allan (Moyamba)	6
Dr. Taylor (Kissy)	4
Dr. Campbell (Kissy)	2
Dr. Renner (Freetown)	2
Dr. Bright (Freetown)	1
Dr. Maxwell (Freetown)	1
Dr. McConaghy (Bo)	1
	34

These cases are now examined in more detail.

The Blue Case Cards have been sent in to the Commission, and speak for themselves.

Dr. Mayhew's cases: No. 1. Dr. Mayhew regarded this as a possible case of typhoid, but the possibility of trypanosomiasis was not excluded.

No. 2. This was regarded by Dr. Mayhew as possibly undulant fever.

No. 3. This was regarded as a possible dengue, though the possibility of gonorrhoea with quinine rash is suggested.

Dr. McConaghy's case is extremely valuable, in that it is stated to be a case of 'Bayloo.' The blood picture does not suggest that it has any relation to yellow fever, but acute yellow atrophy of the liver is a possible explanation. Dr. Collett's case of blackwater fever is fully reported by him; since then, there is information that the patient died of a relapse, on his way to England.

Films sent by Dr. Whitehead. All 8 cases were obtained from European patients, and all showed well-marked numbers of subtertian malaria parasites.

Films sent by Dr. Easmon. Of the 9 films examined, 6 showed well-marked subtertian malaria parasites, and one appeared to be a case of lymphatic leukaemia. Of the remaining two, one had been taken after the administration of quinine, and showed no sign of parasites, and the other, though quinine had not been administered, showed no parasites either. No further account of these two cases was received.

Films sent by Dr. Taylor. Two of these were unfortunately quite impossible to examine, the other two showed plentiful subtertian malaria parasites.

Films sent by Dr. Campbell numbered two ; one contained many subtertian parasites, and the other only showed 27 per cent. of eosinophils as a noteworthy point, and no further account of the case was received.

Films sent by Dr. Renner were two in number. One case showed no malaria parasites, but a polymorphonuclear count of 86 per cent. ; no further account of the case was received. The other case was the blood film of a Roman Catholic Sister with blackwater fever ; the film, unfortunately, was too bad, and no reliable report could be made on it, and no further account of the case was sent.

Films sent by Dr. Bright. Only one was received, and showed 80 per cent. of polymorphonuclears, and no other point of interest. No further account of the case was received.

Film sent by Dr. Maxwell. This was from a case of enlarged femoral glands, without fever, and only for examination for microfilaria.

2. *Material obtained from Hospital sources.* The Colonial Hospital yielded the bulk of the material examined, but a small amount was obtained from the Nursing Home and the Princess Christian Mission Hospital, as shown in the following table:

Colonial Hospital cases	298
Princess Christian Hospital cases	11
Nursing Home cases	11
	320

Only the in-patients of the Colonial Hospital, were under observation during the earlier part of the investigation, but as the available material did not seem to give sufficient scope, the out-patients of the Colonial Hospital were added as material for investigation. Owing, however, to irregular attendance, and the impossibility of continuous observation on these patients, less valuable though more numerous results were obtained than in the case of the in-patients. The supply of cases from the out-patient department was extremely unsatisfactory until I asked for the temperatures of every patient to be taken as a routine, and even then it largely depended on the assistance of the Medical Officer in charge of the out-patients to what extent the temperature was reliable. I have to thank Drs. Whitehead and Young for their help in this matter, for on the occasions when they were in charge of the out-patient department the available material was usually trebled.

The nationality of the patients examined is tabulated as follows:

Natives	270
Europeans	28
Other non-natives	22
	320

Methods of dealing with the Material. This will be discussed under several separate headings.

1. *Clinical.* This varied with the in-patients and out-patients. The procedure in the case of out-patients was as follows: Every case of fever without an obvious 'surgical' explanation was sent in from the out-patient room to the laboratory, which was conveniently placed next door; the case was investigated, a history obtained, a physical examination made if necessary, and then a blood film taken and examined. The mere fact that the case had been handed on to me was an indication by the medical officer in charge of the out-patient room that the physical signs present, if any, were not thought sufficient to account for the condition. These patients were then instructed to report to me when they next attended, in order that I might follow the case up to its termination or examine further if necessary: and further, a note was made on the patient's paper for the guidance of the medical officer in charge of the case.

The procedure in the case of in-patients was as follows: Every patient admitted had his temperature recorded on a four-hourly chart, and the medical officer in charge of the case was expected to withhold quinine, in cases that were not urgent, until a blood examination had been made, and in urgent cases to take a blood film before administering quinine if I was not immediately available. A circular had been issued previous to this investigation calling attention to this point. On the whole, this was very loyally carried out, but sometimes the temptation to administer quinine, in spite of a negative blood examination, could not be resisted.

The progress of cases admitted was noted and any further examination or procedure carried out with the permission of the medical officer in charge. The in-patient cases naturally have been investigated more thoroughly than the majority of out-patient cases, but here there was always the annoyance of checking the temperatures and pulse-rates, owing to the complete unreliability of the native nurses and dressers. These difficulties were enhanced owing to the fact that there was no note taken by the medical officers, either as to the state on admission or progress of the case. There are no forms on which notes could be properly kept, and usually the only remarks attached to the case have been made by the native dresser and are useless, if not misleading. The work of the investigation would be made easier if there were regular hospital notes to refer to, if necessary, provided these notes were a statement of the presence and character of, or absence of, physical signs, and not a simple diagnosis only. A further help in the work of the investigation would be to allocate the clinical work to one investigator and the laboratory entirely to the other, and to allow the clinical investigator to take complete charge (treatment included) of any patient he wished or thought it advisable to investigate.

2. *Microscopical and Chemical.* On practically every in-patient, and as far as possible, though rarely, on the out-patient cases, four routine examinations were made at least once, and repeated if thought necessary. These are dealt with under the following headings:

(*a*) Blood examinations. Dry films were practically the only method employed, and these were invariably stained by Leishman's method, usually within a few minutes of obtaining the film. The wet film method of Seidelin was not tried. Fresh unstained films

were examined on a few occasions. The dark-ground illumination method was not available. It was found that malaria parasites showed up extremely well when stained by Leishman's method, and were as a rule very readily found, so that it was quite the exception to find parasites in a second or third film if the first had proved negative. The length of time to be spent on examining a slide before it was pronounced negative has distinctly increased with the experience gained in the investigation, and it has been my experience on some occasions to have to examine a slide for two to three hours before finding a definite parasite or two. Fortunately it is usual to be able to find parasites within half an hour, and a longer period of examination is the exception. By experience it was found that an early morning film of blood contained more numerous parasites than a film taken at mid-day, or shortly after, when the temperature was usually higher, and therefore morning samples of blood were usually chosen if possible. As a rule the first examination of the blood of an individual was made before the administration of quinine, but on eleven occasions this had been given for a short time, and in spite of this parasites were readily found in six cases; the remaining five cases had to be classed amongst those described as 'doubtful cases.' The statistical results of these blood examinations will be referred to later on under the headings of Malaria, etc.

In all cases where the blood examination for malaria parasites was found to be negative a differential leucocyte count was made. In these counts a minimum of 400 cells was aimed at, but in some cases the white cells have been so scanty that a count of 200 cells has had to be accepted. During this proceeding a look-out was kept for any signs of malaria pigment, which, when found, has aided the diagnosis and given encouragement to prolong the search for parasites. Complete leucocyte counts have occasionally been required and been carried out with the usual Thoma-Zeiss apparatus. Among all the blood films from 345 different patients which have been carefully scrutinised, 201 have shown the ring forms of malaria parasites, and in only nine of these were the crescent forms found; but it must be stated that, as a rule, when ring forms of the parasite had been found, no further actual search for crescents was made.

(*b*) Urine examinations. This, again, has been a routine

practice in all the in-patient cases, and has been carried out as far as possible amongst the out-patient cases. The presence of albumen has been the point to which particular attention has been directed. Amongst the in-patient cases a difficulty has been met with owing to the untrustworthiness of the native dressers, which is best illustrated by quoting an instance where one specimen of urine was watered down and made to serve as specimens from four different patients. The boiling and acidifying test has been the method almost invariably employed, and in my experience it enables the detection of small quantities of albumen with greater ease than by the nitric acid test. The question of small quantities of albumen in the urine has appeared to me to be an important point to investigate on the supposition that a mild case of yellow fever may well show only a trace of albumen, for I have assumed that the less toxic the condition of the patient the less likelihood is there of any damage to the kidneys, or in other words that the albuminuria may be a measure of the severity of the illness.

In order to have some measure of control on the question of albumen in the urine of patients, I have taken the records of the routine examination of urines from patients admitted to the Colonial Hospital and examined by myself in my usual way, quite irrespective of the illnesses of the patients. A total of 437 urines were examined in this way; 248 showed no trace of albumen, but 189 (i.e., 43 per cent.) showed albumen in quantities from a trace upwards, though 60 only (i.e., 13 per cent. approximately) showed it in some quantity. These figures give only a rough idea of the prevalence of slight cases of albuminuria in patients examined in a routine fashion and quite irrespective of their illnesses. The cause of this condition appears to me to be largely the prevalence of chronic urethral disease among the Freetown natives of the hospital class: a prostatitis or gleet is almost the rule above a certain age, and the presence of prostatic threads with the absence of casts is suggestive that the albuminuria is not of kidney origin.

Owing to this state of affairs the difficulty of associating the presence of albuminuria with the illness of the patient is unfortunately increased. I have not considered it justifiable to catheterise patients with urethral trouble in a routine way, and I doubt if they would submit to it.

Under the headings of Malaria, etc., a statistical account will be given of the extent of albuminuria found associated with the condition—without the elimination of urethral disease, however.

(*c*) Faeces examination. This has been a routine measure as far as possible in the in-patients only, and the same difficulty has arisen as with the samples of urine. The examination has purely consisted of examination for the ova of intestinal parasites.

(*d*) Examination for microfilariae. This was a regular practice, the night blood being always taken as a thick film from all in-patients by the native nurses and left for me to examine in the ordinary way by dehaemoglobinising and then staining. It was done purely as a routine, and has not conveyed much information from the point of view of the investigation, except possibly to explain the cause of an eosinophilia in the absence of ankylostomiasis.

(*e*) Other microscopical procedures. Gland puncture for trypanosomes and liver puncture for the parasites of kala-azar are alluded to here: they have only been performed infrequently and in the process of exclusion. Trypanosomes were found on one occasion, and on the only occasion on which a liver puncture fluid was examined there was a negative result as regards kala-azar.

3. *Bacteriological Investigations.* These have not been frequent, and have been entirely carried out by Major Statham. Only one blood culture was attempted in a case suspected to be typhoid, but the culture proved to be contaminated. Four agglutination reactions for typhoid were performed for me, two were negative and the other two, from the same patient, were returned as positive. The bacteriological examination of a urine was carried out in one case; the urine proved to be sterile.

4. *Post-mortem Examinations.* These were performed in every case when permission could be obtained. There were 13 fatal cases among those investigated, and eight of them were submitted to post-mortem examination, and those that were anything out of the ordinary have been reported on the forms specially provided for the purpose. In two of the most important cases post-mortem was refused, but they gave no suspicion of yellow fever.

A control made on supposed Healthy Children

In order to decide whether I was justified in assuming that because malaria parasites were found in an individual's blood therefore that individual's illness was caused by those parasites, a hundred children were examined for malaria parasites as a control. The results obtained have been disconcerting, and it is regretted that this control was not performed as early as possible after starting the work of the Commission.

On two consecutive days early in September, one hundred native children who complained of no form of illness and who were actually engaged in lessons at school were chosen for the experiment. The children were brought one by one, their temperature taken in the mouth, a film of blood taken, and in addition a palpation of their splenic area for any enlargement of that organ, but this latter examination was made in the upright position of the child, and it was not expected to give anything but a rough result.

Each film of blood obtained was stained by Leishman's method and was examined for a complete half hour in the negative cases with a 1/12th oil immersion, followed by a quarter of an hour's examination with a 1/6th objective for crescents. Once a definite conclusion was obtained that parasites were present, no further examination was proceeded with except for crescents.

The temperatures were taken between 10 and 12 noon, and only in 55 cases, when the supply of thermometers failed. The temperatures in these cases ranged between 97° F. and 101° F., with an average reading of 99·17° F.

It should have been mentioned that the ages of the children were obtained as far as possible, and were found to range between 3 and 10 years old, with an average of 6·19 years.

In the 100 films 49 showed parasites, and I have been astonished at the numbers present, as a rule several parasites being found in a few minutes. Among the 49 positive cases 41 were of the subtertian variety, and the other 8 were quartan in type. There was the possibility that one case was a double infection of subtertian and quartan parasites.

Crescents appeared to be conspicuous by their absence, for they were only found in one of the films.

As regards the splenic enlargement, I have noted that in 28 per

cent. of the cases it was enlarged from a finger's-breadth upwards.

The results obtained by this control have been disconcerting to me, for I did not appreciate that native children harboured the *active* form of malaria parasites to such an extent, and I now am in doubt whether I have been justified in placing on one side all those cases harbouring malaria parasites, as cases of malarial fever, under the impression that I had satisfactorily completed the diagnosis.

Classification and Discussion of Cases

The cases which I shall deal with in the following pages are those with which I have been in contact personally, but they include, in a few instances, cases which have been sent to me, and in which I have only the knowledge obtained from an examination of the blood film.

The following table gives the diagnoses and the numbers of cases so diagnosed :—

Malaria	201
Doubtful cases (Pyrexia of short duration)	33
Doubtful cases (Pyrexia of longer duration)	15
Pneumonia	14
Phthisis	10
Bronchitis	5
Gonorrhoea	3
Blackwater fever	2
Enteric fever...	2
Whooping cough	2
Pleurisy	2
Septicaemia	2
Pyorrhoea alveolaris	1
Lymphatic leukaemia	1
Measles	1
Dysentery	1
Acute myelitis	1
Acute rheumatism	1
Lymphadenoma	1
Nephritis	1
Broncho-pneumonia	1
Abscess of lung	1
Trypanosomiasis	1
Surgical (various)	3
Afebrile cases	7
Incomplete (only seen once)	30
	342

It will be noted that the cases definitely diagnosed as malaria form nearly 60 per cent. of the cases.

Unfortunately two large groups of cases occur which have been given the titles of 'Doubtful Cases,' divided into those showing long and short periods of pyrexia respectively, and another group described as 'Incomplete,' because they were only seen on one occasion and gave no suggestion as to the cause of the illness.

The cases making up these groups will be examined in detail later, and I shall now proceed to discuss the main groups of disease met with, if there is any suggestion that they are of value from the point of view of the investigation.

At first sight, it may appear odd that such a variety of disease could have been met with in the process of the investigation of fevers of interest to the Commission, but they all have needed investigation because in the first place the diagnoses were uncertain, and they came out in the weeding-out processes of the investigation. It would have been expected that such illnesses as gonorrhoea would never have crept in, but it is by no means uncommon for a venereal cause of illness to be hidden purposely by the patient. I have thought it advisable that every case that I attempted to investigate should be included in my report, however ridiculous it may seem when completed as regards diagnosis, for it is only an error in the right direction.

(A) *Malarial Cases*

These have numbered 201 out of a total of 342 investigated by myself. The following varieties have been met with:—

Subtertian	191 =	95 per cent.
Quartan	9 =	4·5 per cent.
Benign tertian	1 =	0·5 per cent.

In view of the result of the control obtained from 100 films of blood, I have endeavoured to sub-divide these malaria cases into groups, in order to estimate those numbers which may be regarded definitely as correctly diagnosed, by separating off a group containing all natives under the age of 15 years:—

Europeans	23	119	201
Syrians	10		
West Indians	4		
Natives over 15 years	82		
Natives under 15 years	82		

It appears to me that 119 may be considered to be correctly diagnosed, and of the remaining 82, probably 50 per cent. (if we may judge by the control) may be considered as only possibly and not definitely wrongly diagnosed.

It may be of interest to note here roughly the extent of the infections usually met with :—

'Scanty infections'	20·8 per cent.	
'Readily found'	56·7 per cent.	79 per cent.
'Abundant'	22·3 per cent.	

Among the 42 patients described as having scanty infections no less than 8 are Europeans, and this is probably explained by the habit of taking quinine occasionally.

I have made no attempt at enumeration of parasites at any time, but my experience gives me the impression that there is no relation between the height of a febrile attack and the number of parasites found in the *peripheral* blood, though this opinion is only intended for European patients: with the native patient I am not prepared to give the same opinion. It appears to me that this is an important point, for there is a tendency to assume in a European patient, who is seriously ill, that there should be a heavy infection with malaria, and when an examination of his blood is made and parasites not readily found, to jump to the conclusion that the case is not one of malarial fever. I am very definitely of the opinion that prolonged searches for the malaria parasite may be necessary, and should be made before it is justifiable to assume that the case is not malarial in origin.

A history of vomiting is by no means infrequently given by the patient in these malarial cases, but in no case has it ever been stated to be black. Blood of bright red colour was stated to have been vomited by one patient who had a heavy infection of benign tertian in his blood, but this statement was not confirmed after he came under observation.

Jaundice was quite definite in one case only, and was only of short duration: he further had a very heavy infection with subtertian parasites and a certain amount of albumen in his urine, but there was no vomiting or Faget's sign. It will be as well to note here how easy it is to think there is an icteric tint in an adult

native's conjunctiva; this is due to a pigmentation which is extremely common in the adult native: in a native child, owing to the absence of this pigmentation, jaundice is readily recognized.

Albuminuria. Urine examinations in these malarial cases has not been so frequent as I could wish: this has been due to two reasons—firstly, because the diagnosis of malaria having been made on the blood condition (before I had been put on my guard by the control observation) any further examination of the patient was imagined to be unnecessary; and secondly, because most of the malarial cases were out-patient cases, which made this further procedure rather awkward. However, there have been 42 examinations of urine among the in-patient cases: 21 showed no albuminuria, and the remaining 21 showed its presence as a 'thin cloud' with the acidifying and boiling test. In one case there was quite a 'heavy cloud' of albumen.

Conjunctival injection was not observed at any time.

Faget's sign was not noted amongst the 68 in-patient cases, but a considerable slowing of the pulse is no uncommon condition to note in conjunction with the fall of temperature after any short and acute toxic illness.

(B) *Doubtful Cases*

I think these cases can be divided advantageously into two groups:—

1. Pyrexia of unknown origin and short duration.
2. Pyrexia of unknown origin and usually beyond seven days' duration.

By this classification those cases which are of particular interest from the yellow fever point of view will be found separated from the fevers of long duration.

I have thought it advisable to collect these cases together in the form of a table giving all available details, and a column giving what I thought was the probable or possible explanation of the illness from the state of the patient.

Table I.—Doubtful Cases—Pyrexia of Short Duration

No.	Case No.	Nationality and age	Duration of fever	Highest Temperature observed	Has quinine been given before blood examination ?	Headache	Vomiting	Albuminuria	Faget's sign	Remarks and possible explanation
1	59	European, 35	3 days	104	Yes, for 5 days	Present	Absent	Nil	Absent	No rash. No secondary rise of temperature. Case not reported to me before 5th day
2	166	Susu, 36	2 days	100	Yes, for 2 days	Absent	Slight	Nil	Absent	Constipated. ? Mucous colitis
3	244	Creole,* 32	2 days	99·6	Yes, for 1 day	Present	Absent	—	—	? Malaria. Well the next day
4	265	Syrian, 40	3 alternate days	99·2	Yes, routine 2 grs. a day	Present	Absent	Faint cloud	—	? Malaria. Large mononuclears 32 per cent.
5	6	Timnee, 22	1 day	100	No	Present	Absent	—	—	Constipated. Cleared up with aperient
6	47	Susu, 27	2 days + secondary rise	104	No	Backache	Absent	Nil	Absent	'Blue card' case. ? Dengue
7	82	Limbah, 28	3 to 4 days	100	No	Absent	Absent	Faint cloud	Absent	Bronchial catarrh
8	84	Creole, 23	4 to 5 days	101·4	No	Absent	Absent	Considerable	Absent	'Blue card.' ? Pyelitis and gonorrhoea
9	93	Creole, 24	4 days	103	No	Absent	Absent	Faint cloud	Absent	? Pleurisy. Polymorphonuclears 73 per cent. 'Blue card'
10	103	Creole, 29	2 days	102	No	Absent	Absent	Nil	Absent	Cough. ? Thickened pleura. Polymorphonuclears 72 per cent.
11	149	Timnee, 28	2 to 3 days	99·6	No	Absent	Absent	Nil	Absent	Slight cough, and pain in right side
12	196	Mendi, 41	1 day	99·6	No	Present	Absent	—	—	Seen again in 3 days and was well
13	202	Creole, 11	2 days	99·6	No	Present	Absent	—	—	Constipated. Well when seen again
14	170	Congo, 15	4 days	102	No	Absent	Absent	Nil	Absent	Enlarged groin glands ? cause
15	227	Congo, 40	3 days + secondary rise	103	No	Backache	Absent	Faint cloud	Absent	'Blue card' case. ? ? Dengue

* See footnote, page 406.

TABLE I.—*continued*

No.	Case No.	Nationality and age	Duration of fever	Highest Temperature observed	Has quinine been given before blood examination?	Headache	Vomiting	Albuminuria	Faget's sign	Remarks and possible explanation
16	245	Creole, 20	1 day	99·8	No	Present	Absent	Faint cloud	Absent	Slight diarrhoea. Well next day
17	256	Susu, 30	2 days	101	No	Present	Once	Faint cloud	Absent	Malaria pigment found
18	259	Creole, 23	1 day	100·8	No	Present	Absent	—	—	Same case as No. 8. Did not return
19	281	Creole, 25	4 to 5 days	100·2	No	Present	Absent	Faint cloud	Absent	Constipated. One crescent found
20	301	Creole, 13	5 days	99·2	No	Present	Absent	Nil	—	Eosinophils 30 per cent. Seen again in 3 days, well
21	304	Creole, 26	3 days	100·6	No	Present	Absent	Faint cloud	—	Eosinophils 18 per cent.
22	309	Creole, 23	2 days	99·4	No	Present	Absent	—	—	One crescent found
23	310	Sherbro, 14	3 days	99·4	No	Present	Absent	Nil	—	Has cough. No physical signs
24	311	Creole, 17	5 days ?	100·6	No	Present	Present	—	—	Little malarial pigment seen. Large mononuclears 17 per cent.
25	320	Creole, 33	3 days	99·4	No	Present	Absent	—	—	Coryza and slight pharyngitis
26	321	Creole, 21	3 days	99	No	Present	Absent	—	—	Coryza
27	324	Creole, 21	1 day	102	No	Present	Absent	Nil	Absent	Coryza
28	344	Creole, 19	2 days	100·6	No	Present	Absent	Nil	Absent	Coryza and neuralgia
29	357	Creole, 12	4 days	100·2	No	Present	Once	Nil	—	Has cough. Well the next day
30	358	Creole, 21	2 days	99·8	No	Present	Absent	Nil	Absent	Slight coryza. Well next day
31	362	Creole, 58	4 days	99·6	No	Present	Absent	—	—	Has cough
32	368	Creole, 30	2 days	100	No	Present	Absent	Nil	Absent	Coryza
33	308	Creole, 19	2 to 3 days	?	No	Present	Absent	Very faint	Absent	Complained of sore throat. 'Blue card'

2. *Doubtful Cases—Pyrexia of long duration*

There have been 15 cases placed in this category, and all but four have already been reported to the Commission on the 'blue cards' or 'white forms' that were provided for the purpose. For the reason just stated these cases will not be discussed in detail, except in the four instances where no report was sent in. In order that the cases may be traced more easily, I have enumerated the complete list.

(*a*) A West Indian, Case No. 37. Has been reported on a 'white form.' Since reporting this case I have cut sections of the post-mortem material with the following results :—

Spleen.—Large caseating areas but no giant cell systems seen, and no acid fast bacilli found on staining appropriately.

Kidney.—No pathological changes noted.

Portion of thickened omental tissue.—Very early signs of caseation and several giant cell systems seen, but no acid fast bacilli.

The case probably was an obscure and unusual form of tuberculous disease, in spite of the fact that no acid fast bacilli were seen.

(*b*) A half-caste child, Case No. 38. This case has been reported on a 'blue card' and was of interest in view of the peculiar bodies found in smears made from liver puncture fluid. The only other point to note here is that the case has been published by special permission of the Commission, and appeared in the December number of the R.A.M.C. Journal.

(*c*) A half-caste child and brother to the above case. A liver puncture was not allowed on this case, and unfortunately the possibility of typhoid did not occur to me at the time, so that a Widal's reaction was not done.

(*d*) A Kroo woman, Case No. 58. This case has been reported on a 'blue card.' I have nothing further to note.

(*e*) A Creole,* Case No. 73. This case was reported to the Commission on a 'blue card.' The diagnosis of liver abscess was suggested. A post-mortem was refused.

(*f*) A Timnee man, Case No. 75. This case was reported on a 'blue card.'

(*g*) A Creole boy, Case No. 104. This case was also reported on a 'blue card.' I cannot suggest a probable diagnosis; the presence of ankylostomes in the faeces is noted, but there was no eosinophilia to suggest that the illness was due to these parasites.

(*h*) A Creole man, Case No. 125. This case was not reported, for it was not considered to throw any light on the problems of the Commission. The patient gave 14 days' history of illness, chiefly abdominal pain and cough, and denied a history of dysentery. The heart was displaced one inch to the left, and there were no cardiac murmurs. There was considerable dullness at the base of the right lung, and the liver was palpable 3 to 4 inches below the costal margin. The right pleura was explored by the Medical Officer in charge with

* For the significance of the word 'Creole' as used by Lieutenant-Colonel Statham, Dr. Butler, Dr. Dalziel and Dr. Johnson in their reports, *vide* Lieutenant-Colonel Statham's report p. 356 *supra*.

an aspirating needle and 2 pints of blood-stained serum removed, but there was no exploration of the liver. The temperature chart usually showed an evening rise to between 99·4° and 101° F. The liver gradually increased in size and a little ascites developed. The polymorphonuclear count rose from 61 per cent. to 78 per cent. The patient remained in this state for two months in hospital, and then refused to have any other treatment and went out. The diagnosis of liver abscess is suggested.

(*i*) An Indian, Case No. 126. This case has been reported on a 'blue card.' The question of kala-azar was not excluded because the patient refused to allow a liver puncture.

(*j*) A Creole child, Case No. 168. The child was emaciated, with a month's history of some looseness of bowels. There were no physical signs of an abnormal nature except a general moderate enlargement of glands. The mother removed the child when it was suggested that one of these glands should be removed and examined. The ward diagnosis was 'Tuberculosis.'

(*k*) A Creole child, Case No. 201. This case has been fully reported on a 'white form.' I cannot suggest a diagnosis: the tongue and peeling distinctly suggested scarlet fever, but there were no complications or sore throat to confirm the diagnosis. Meningitis was at first suspected.

(*l*) A Syrian, Case No. 210. This case has also been fully reported on a 'white form.' The main feature was the extraordinary rise in the percentage count of the eosinophils.

(*m*) A Sherbro man, Case No. 293. This patient was admitted with a history of cough and pain in his chest, and there was definite dullness at the right base with diminished resonance. He denied ever having had dysentery. There was irregular fever up to 100° or 101° F. during his stay in hospital. The Medical Officer in charge of the case explored the right pleura with an aspirating needle, but there was no exploration of the liver. The patient was given emetine once, but refused further treatment and went out. Polymorphonuclear count 86 per cent. Probably liver abscess.

(*n*) A Creole child, Case No. 336. This case was not reported. A marasmic child, with rather enlarged glands as the only special feature. The child was stated to have been ill for three days, and during its stay of five days in hospital the temperature ranged between 99° and 101° F. No diagnosis was made, and the child was removed on the suggestion of a gland being examined.

(*o*) A Sherbro man, Case No. 372. This case has been reported on a 'blue card.' The suggestion of a mild form of small-pox was made.

(C) *Incomplete Cases—'only seen once'*

I have thought it advisable to include these cases and to give as many details as I am able. They are given in tabular form.

No.	Case No.	Nationality and age	Ill for	Temperature	Remarks
1	8	Galliness, 35	2 days	101	Complained of rheumatism. Polymorphonuclears 70 per cent.
2	9	Creole, 4/12	?	103·6	Spleen not enlarged. Liver enlarged
3	10	Creole, 9	?	99·6	Said to have worms. Eosinophils 9 per cent.
4	14	Creole, 4/12	?	101·8	Film from Dr. Renner. Polymorphonuclears 86 per cent.
5	19	Creole, 21	?	99	Constipated. Eosinophils 9 per cent.
6	71	Creole, ?	?	?	Film sent by Dr. Campbell. Eosinophils 27 per cent.
7	72	?, ?	?	?	Film sent by Dr. Bright. Polymorphonuclears 80 per cent.
8	114	Indian, 30	?	99·4	Anaemic. 'Always fever and headache'
9	141	W. Indian, 5	2 days	100·6	Large mononuclears 15·5 per cent.
10	173	Creole, 25	4 days	98	No fever when examined. Eosinophils 18 per cent.
11	174	Mendi, 30	1 day	100	
12	183	Creole, 17	4 days	?	Large mononuclears 22 per cent.
13	184	Creole, 28	6 days	97	
14	185	Creole, 34	5 days	98	Eosinophils 21 per cent.
15	218	Creole, 23	6 days	100	History of several miscarriages
16	219	Creole, 33	7 days	100	Has mitral disease
17	248	Creole, 3	7 days	100	Said to vomit daily
18	250	Creole, 14	1 day	?	Constipated. Polymorphonuclears 71 per cent.
19	262	W. Indian, 36	3 days	99·8	Constipated.
20	264	Creole, 26	2 days	99	
21	267	Creole, 22	2 days	99·8	No headache
22	273	Creole, 41	7 days	99·6	Constipated
23	285	Creole, 2	4 days	99	1 crescent seen
24	299	Creole, 33	7 days	99·2	? Syphilitic. Constipated
25	319	Creole, 36	?	100	Chronic headache. ? Syphilis
26	335	Creole, 15	4 days	100	Tongue very dirty
27	338	Creole, 25	1 day	100·6	No headache
28	340	Creole, 30	2 days	100·6	
29	341	Timnee, 3	2 days	100·2	Little malaria pigment seen
30	364	Creole, 30	? 1 month	101	

In the remarks column of the above cases has been placed some symptom or statement obtained in the history which might bear on the case: in almost every instance there was a history of 'fever and headache,' and this has been the reason why the case has been examined even if the temperature was not 100° F. at the time.

It is of course to be understood that the above cases which have been dealt with under the headings of 'Doubtful' and 'Incomplete' have been placed in these groups not only because the symptoms and signs failed to suggest a diagnosis, but also because the blood examination failed to reveal the presence of malaria parasites.

Having alluded to those cases under the respective heads of—

Malaria.

Doubtful Cases—1. Of short duration.

2. Of long duration.

Incomplete Cases—'only seen once.'—

there remain those in which a definite diagnosis has been made, and these will be dealt with shortly.

Pneumonia. There have been 14 of these. The diagnosis has been made purely on physical signs and the course of the illness. One of the cases was of particular interest, for in the course of the routine blood examination it was discovered that the patient was suffering from lymphatic leukaemia. The blood count showed a total white count of 75,000 per c.mm. and a differential count of nearly 90 per cent. small lymphocytes. The diagnosis was confirmed by post-mortem examination and sectioning of the tissues.

Phthisis. There is nothing of special interest to be noted here. There were ten cases in all, and each was finally verified by finding the bacillus in the sputum.

Bronchitis. Only five cases have been put in this class. The sputum was examined in each case except that of a child of nine months: no tubercle bacilli have been found, and the physical signs have warranted the diagnosis.

Gonorrhoea. It is to be regretted that three cases should have been investigated as fever cases, but in each the condition had been deliberately hidden. One case was in a European admitted to the Nursing Home, and the other two occurred in two native Government officials.

Blackwater Fever. Both cases have been reported already to the Commission. One case in a European patient was a private case of Dr. Collett's, and he has reported the case on a 'blue card.' The other case was interesting in that it occurred in a native child and presented two different attacks of haemoglobinuria, which I think can be associated with an intense malarial infection in the first attack, and with the administration of quinine in the second attack. The case has been reported fully on a 'white form.'

Enteric Fever. Two cases have been placed in this group. In the first case, owing to misfortune, the diagnosis could not be proved bacteriologically, and the diagnosis has been based on the post-mortem appearances only. The second case ran a more or less typical course, except for complications, and was further proved by the agglutination reaction. Both cases have already been reported.

Whooping Cough. Two cases have had to be placed under this heading as the only condition present to account for the 'fever'; the illness was severe in each case. In one of the cases crescents were found, but no active forms of the parasite.

Pleurisy. Two cases of 'fever' have had to be relegated to this group: in one case phthisis was suspected but not proved; in the other case the illness commenced with a rigor, and appeared like an abortive case of pneumonia.

Septicaemia and Pyaemia. Two cases occurred: one was puerperal in origin: the other has been reported to the Commission on a 'blue card,' and was suggestive of being pneumococcal in origin.

Pyorrhoea alveolaris. One case of 'fever,' I think, can be definitely ascribed to this condition, and the case has been reported on a 'blue card.'

Lymphatic Leukaemia. This was one of the cases from which a film was sent by Dr. Easmon; no further account of the case was received.

Measles. I think this was quite a definite case; it was suspected on account of Koplik's spots. It ran the usual course.

Dysentery. This case only came under notice because of the statement of vomiting in the history, and the possibility of the illness being malarial in origin.

Acute Myelitis. One case occurred and has been reported on a 'white form.' Unfortunately the spleen culture at the post-mortem was found to be contaminated, and the cord unsatisfactory for sectioning.

Acute Rheumatism. Only one case was found, and it is the first probable case I have seen. The case has been reported for this reason.

Lymphadenoma. One case of the generalised disease is reported, though no gland was removed for section cutting, owing to the serious condition of the patient, and therefore the case is regarded as this disease by the process of exclusion only. Gland puncture did not reveal the presence of trypanosomes. The case has been reported on a 'blue card.'

Nephritis. This case was investigated owing to the presence of 'fever' in the early part of the illness, which, however, rapidly subsided, and the case ran the course of an ordinary chronic nephritis.

Broncho-pneumonia. Only one case has to be placed in this group: the physical signs eventually became quite definite.

Trypanosomiasis. One case only proved to be this condition; the case presented very few signs of the condition, except possibly mental. The glands were almost unnoticeable, but the diagnosis was proved by gland puncture.

Surgical and Afebrile. These cases numbered 10, and came to be investigated in the first place, owing to an error.

The Problems before the Commission

Owing to my short experience of Sierra Leone it is quite impossible for me to make any serious attempt to answer the questions of the Commission, but in order to be systematic I shall follow the order of these questions in the few remarks that I shall add.

1. The Fevers affecting Europeans. During the investigation 28 Europeans have passed through my hands, and the fevers affecting these patients can be divided into the following groups:—

Malaria	23
Blackwater fever	1
Septic and Respiratory fevers	3
Doubtful (probably malaria)	1
	28

2. Amongst non-natives, besides Europeans met with during the investigation, are Syrians, Indians, and West Indians. There have been 22 of these through my hands, and of these 15 have been definitely diagnosed and are classified as follows:—

Malaria	14
Respiratory fever (Pneumonia)	1
Doubtful (? ? Kala-azar in one)	7
	22

Amongst natives, besides the ordinary septic, and what may be called fevers due to respiratory tract infections, the following fevers (excluding malarial fever) have been met with:—

Blackwater fever	1
Typhoid fever	2
Measles	1
Acute rheumatism	1
Trypanosomiasis	1
	6

It should be stated that the term 'Respiratory fever' is only a general term applied to fevers due to infections of the respiratory tract.

3. The presence of certain fevers in Sierra Leone.

(*a*) *Dengue.* In view of the very characteristic epidemic outbreaks that are usually associated with this disease, its presence in Sierra Leone should be an easy problem to solve. No such epidemic has come to my knowledge. During the investigation attention has been particularly directed towards mild forms of fever, with the result that two cases of fever have been recorded that may arouse a remote suspicion of dengue. These two cases have been reported on the 'blue cards,' and are referred to under the cases described as 'Doubtful—Pyrexia of short duration.'

(*b*) Pappataci Fever, Typhus, Rocky Mountain Fever, Undulant Fever, Para-undulant Fever, and Cerebro-spinal Fever have not been

recognised as yet during the course of the investigation. It should be stated here, however, that a case reported by Dr. Mayhew from Daru was regarded by him as a possible case of undulant fever. The case is reported on a 'blue card.'

(*c*) *Typhoid Fever.* One undoubted case, I think, has been reported during the work of the Commission: this case clinically was a case of typhoid, and the agglutination reaction was positive. A second case occurred, which, however, was not proved bacteriologically, and did not resemble the condition clinically; but in view of the characteristic ulceration at the post-mortem the diagnosis seems very probable.

4. *The nature of certain fevers termed*:—

Bilious Remittent Fever. I think three cases that were classed amongst the malarial cases can be alluded to under this heading. I have reported two of the cases on 'blue cards,' but the third case was a private patient of Dr. Renner's, for whom I examined the blood; but I have no further information than I obtained at the time.

In all three cases the blood was swarming with subtertian malaria parasites, and the cases showed a chart of remitting fever, while bilious vomiting was a marked feature. Improvement was rapid in two of the cases, but the third was fatal, and at the request of the friends no post-mortem was performed; but in view of the blood condition I think there can be no doubt as to the causation of the disease.

The urine showed the presence of albumen as a 'cloud on boiling,' which in one of the cases was found to be considerably less at the next examination. In the fatal case there was suppression of urine, and no urine remained in the bladder.

The vomited material in all three cases showed no signs of blackness or altered blood particles, and was purely of a bilious nature.

Inflammatory, Endemial, and Acclimatising Fever. I have not met with nor have I ever heard the terms used in Sierra Leone in alluding to any fever.

Hyperpyrexial Fever. The death register shows a case certified as a case of malaria in a European child of 2 years, and the medical man in charge of the case informed me that the

child had a temperature of 108° F. I received no blood film, and have not received any account of the case. This case is the only one that I know of that might possibly have been included under this heading.

Low Fever. I have reported on a 'white form' the case of a native youth who had a persistent low form of fever which I could not account for; the ulcer on his leg appeared to be the only possible explanation, but this ulcer was perfectly clean and healing satisfactorily. Agglutination reactions performed with typhoid and para-typhoid bacilli were quite negative.

Febricula. My experience of this diagnosis is that it has been used for and synonomously with 'Pyrexia of unknown origin.' I have not met with any case diagnosed in this way during my period of the investigation.

5. *Infant Mortality.*

This is an important question, and a small attempt has been made to deal with it in the following way, owing to other methods not being available:—

(*a*) The examination of the Death Register for deaths under the age of 1 year.

(*b*) Examination of women as regards the history of their pregnancies.

From May 1st to September 14th, inclusive, 96 deaths were recorded as having taken place at 1 year or under, and when classified they fall into certain groups. It should be stated that the cause of death, in the uncertified cases, has been presumed purely on the information obtained from the friends or parents by a native, unqualified in medicine, though not therefore necessarily inexperienced in the local illnesses.

	Uncertified	Certified	Total
Convulsions	30	0	30
Immaturity	27	0	27
Pulmonary troubles	16	3	19
'Fever'	11	0	11
Whooping cough	5	1	6
Wasting	2	1	3
	91	5	96

It is to be noted that Convulsions, Immaturity and Wasting, with a total of 60 cases, account for 62 per cent. of the deaths in this age group, whereas the remaining 36 cases, which were probably definite febrile illnesses, form only 28 per cent. of the deaths. It is probable that many of the convulsion cases might have been febrile illnesses, but they have not given this impression to the recorder of the deaths in the Register. I shall not draw any conclusions on these results, but will proceed with the next method of elucidating the problem, in case that may aid the solution.

The Histories of 263 women of Freetown

The account of the pregnancies that occurred amongst 263 native women was obtained from them direct, and a total of 804 pregnancies accounted for. They were tabulated as follows:—

Stillborn or miscarried	111	= 13·8 per cent.
Died within 12 months of life	113	= 14·0 per cent.
Died between 1st year and 5th year ...	90	= 11·2 per cent.
Lived beyond 5 years	490	= 61·0 per cent.
	804	100·0 per cent.

Some light may be thrown on the probable cause of the 111 stillborn and miscarried pregnancies by two points:—

1. The prevalence of syphilis. I think it can be safely asserted that this condition is very common.
2. The comparative rarity of congenital syphilis. It is quite unusual to come across this condition in the hospital records and out-patient cases, and I have heard this statement borne out by several medical officers.

In my opinion, these two points explain themselves when the third point is given that 13·8 per cent. of pregnancies, amongst the 804 described by the women themselves, have ended either in miscarriage or stillbirth.

It must not be assumed that congenital syphilis is never seen, for though I have never yet seen a case showing Hutchinson's teeth amongst the natives of Freetown, I am beginning to see more cases of wizened and marasmic children with typical syphilitic 'wigs'

who give me the clinical picture I have previously associated with congenital syphilis.

In view of the possibility, or even probability, that the majority of the pregnancies that end by miscarriage or by stillbirth are due to syphilitic infection in the parents, a suggestive light is thrown on the possible cause of death in many children within the first year of life. It also increases the probability that a syphilitic infection can be given as the cause of 60 per cent. of the deaths which are apparently due to afebrile causes, and which were found amongst the deaths of children below the age of one year in the death register. Again, on analysing the cause of death amongst the results of 113 pregnancies that ended fatally within the age of one year, it will be found that convulsions and wasting together account for 40·7 per cent., and this total is increased to 57·5 per cent. if 19 cases are included in which not even fever or respiratory illnesses could be given by the parents as an explanation of the cause of death, which was simply stated as 'unknown.'

It may appear that I have rather laboured the point, but I am distinctly of the opinion that syphilis very largely affects the rate of infant mortality in Freetown.

6, 7, 8, 9, 10. With the questions asked under the heading of these numbers, I regret that I am quite unable to supply any information as yet.

Conclusions

1. That up to the end of my period of work for the Investigation no case suggestive of yellow fever was met with.

2. The presence of typhoid fever in a native was established, and there did not appear any reason to presume that the case was infected from an imported case.

3. That the out-patient cases of a hospital, as a rule, do not yield any material of real value, owing to the difficulties of obtaining continuous observation.

4. That in view of a control that has been made on the blood of supposed healthy children, it is not advisable to assume that because a child shows numerous malaria parasites in its blood,

it is therefore suffering from malarial fever, unless further observations confirm this view.

The members of the Commission, at the meeting at which I attended, expressed a hope that a frank expression of opinion should be included in the report they asked me to prepare.

It is only possible for me to express an opinion by retailing certain facts, and how I consider the work of the investigation can be aided.

1. If possible, every medical officer should be provided with a suitable pocket-case containing slides, needles, a small length of thin rubber tubing and a glass writing pencil, which he will be expected to take to every case visited by him, so that he may be able to take a sample of blood from every case of 'fever.'

2. There are still a large number of cases regarded as 'ordinary fever' or 'typical malaria' where a blood examination has not been performed and is regarded as unnecessary. This state of affairs should be remedied, though I may say that there has been considerable improvement since the inauguration of the work of the Commission. A common excuse for the neglect of blood examination is that 'the patient has already taken quinine.'

3. That every case returned as Intermittent, Remittent, or any other form of Malarial Fever, or any undefined fever, should be queried, unless the result of a blood examination is given in an accompanying report, with, in the negative cases, a statement of the time spent in examining the slide; otherwise the slide should be sent to headquarters for re-examination.

4. That suitable forms for note-taking be provided for all in-patient cases, and that the notes and progress of the case be taken by the medical officer in every case. These notes in cases of fever should be sent to the investigators if required.

5. That there should be a standing rule that complete post-mortem examination is to be made on every case dying in hospital, without exception, unless an objection has been raised by the friends, and then if necessary through the Coroner's aid.

EXPERIMENTS AND OBSERVATIONS ON YELLOW FEVER

BY

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[This paper was read before the Royal Society of Medicine, and published in the Proceedings of that Society, Vol. VII, 1914 (Medical Section), pp. 49-67. It has also been published in the Yellow Fever Bureau Bulletin, Vol. III, No. 2, pp. 121-144. It has therefore not been thought necessary to republish it in this volume.]

SUMMARY REPORT OF INVESTIGATIONS CARRIED OUT UNDER THE YELLOW FEVER (WEST AFRICA) COMMISSION OF THE COLONIAL OFFICE, AUGUST, 1913—JANUARY, 1914

BY

HARALD SEIDELIN, M.B. (Copenhagen), M.D. (Mexico), *Scientific Secretary, Yellow Fever Bureau, School of Tropical Medicine, Liverpool.*

On July 16th, 1913, I sailed from Liverpool, and arrived at Accra, on the Gold Coast, on July 31st, in order to carry out investigations under the Yellow Fever Commission. On my arrival I was informed that there were at present no cases of yellow fever in Accra, but that several cases had occurred quite recently in Lagos, the capital of Southern Nigeria. It was left for me to decide whether I would proceed at once to Lagos, or whether I considered it advisable to start work in Accra and possibly, later on, proceed to Lagos. The chief object of the systematic investigations in West Africa was, as far as I understood it, not so much a careful study of more or less typical yellow fever cases, but much more an enquiry into the conditions during the apparently yellow-fever free periods, in order to find out how the intervals between outbreaks of the disease were bridged over. I, therefore, decided to start work in Accra, where I became associated with Dr. A. Hutton, of the West African Medical Staff. We received the most efficient assistance in our investigations from Dr. Hopkins, Principal Medical Officer, and from all the Medical Officers with whom we came in contact. His Excellency the Governor, Sir Hugh Clifford, took great interest in the work, ordered that all facilities should be afforded us, and established two dispensaries, one in Christiansborg and one in Labadie, in order to make it possible to obtain a considerable amount of material, from native children, for observation. In these dispensaries we observed a large number of children, making examinations of the blood whenever we found any rise of temperature or any complaint the nature of which was not at once clear. Unfortunately the result was negative; in no case was the *Paraplasma flavigenum* found, whilst, on the other hand, malaria parasites were present in the majority of cases. An examination of a small

number (14) of school-children was likewise negative so far as the *P. flavigenum* was concerned. The only result of a positive nature which we obtained during two months' work was the demonstration of *P. flavigenum* in the blood of two patients suffering from mild febrile disorders, not unlike the mild cases of yellow fever, which have been described from various localities by many observers, including myself. The first of these patients was a native of West Africa, but not of Accra; the second case occurred in a European who had arrived in West Africa shortly before he was taken ill.

Several other cases of fever came under observation, which were of no particular interest in regard to the question of unrecognised fevers in West Africa. One case should be mentioned, in which a diagnosis of dengue was made, a disease which has rarely been diagnosed on the Gold Coast, but which may be more common than it is at present suspected.

Towards the end of September I received instructions from the Secretary of State to proceed to Lagos as soon as possible, which I did, taking the first available steamer, and arriving in Lagos on September the 27th. After a conference with the Principal Medical Officer, Dr. Hood, I established my headquarters at the Medical Research Institute, Yaba, at a short distance from Lagos. Here I became associated for a short time with Dr. J. W. Scott Macfie, Acting Director of the Institute, who had already conducted important investigations on the subject of yellow fever, together with Dr. J. E. L. Johnston. Towards the end of October the newly-appointed Director of the Medical Research Institute, Dr. A. Connal, arrived, and from this time until the beginning of February, 1914, when I left Lagos, we worked constantly and intimately together, receiving valuable assistance from Mrs. S. Summers-Connal, late Assistant Entomologist at the London School of Tropical Medicine, to whom I feel greatly indebted for her untiring voluntary aid in all our mosquito-work.

On my arrival in Lagos there was only one yellow fever patient, a convalescent, in the hospital. This patient I saw with Dr. Leonard, and then went, on September 30th, together with Dr. Hood, to Forcados, in order to see some cases which Dr. Bailey had under observation. When we arrived, on October 1st, these cases had already recovered, or were well on their way to recovery, and I

returned to Lagos on the following day, after having seen Dr. Bailey's cases in the evening of October 1st and on the morning of October 2nd. After my return to Lagos on October 3rd, I worked in the Yaba Institute for the remainder of the time at my disposal, visiting Lagos as often as necessary in order to observe cases in the hospital or to make necessary arrangements.

The human cases observed in Lagos are dealt with in a separate paper. They showed somewhat varied types of the disease, but presented no particularly striking features and no essential difference from cases of yellow fever observed in Yucatan.

It is of special importance to note that we found *P. flavigenum* in a certain number of individuals, more especially children, who presented no other sign of illness than a slight rise of temperature. These cases are dealt with in a separate paper on 'pseudo-carriers.'*

The principal part of the work carried out at the Yaba Institute was experimental infection of guinea-pigs, which is reported upon in a paper by Dr. Connal and myself.† Our most important results were that *P. flavigenum* was transmitted from one guinea-pig to another, twenty-three passages being the maximum when I left Yaba, and that I carried infected guinea-pigs home to England, where the strain is now being kept up by Professor E. E. Glynn and myself at the University of Liverpool.

We were able to demonstrate the presence of *P. flavigenum* in nearly all cases of infected guinea-pigs, in the peripheral blood and when the post-mortem examination was performed shortly after death, also in heart-blood and in various organs. In addition to the ordinary forms of the parasite we found, in lungs and other organs, 'blue bodies'; we suggest that these bodies represent stages of division. The infection produced as a rule marked symptoms, especially rise of temperature, gastric lesions, and albuminuria.

I regret that we were on this occasion, as in the case of my previous investigations, unable to demonstrate the evolution of the parasite in the mosquito, though we performed a number of experiments with this object in view. We found considerable difficulties in keeping the mosquitoes alive during the whole duration of the

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* H. Seidelin, On the Existence of 'Pseudo-Carriers' of the infection in yellow fever. *Y. F. Bur. Bull.*, III, 3, pp. 198-202.

† *Vide* page 427 *infra.*

experiments, one of the difficulties being that the guinea-pigs, when exposed to the bites of the mosquitoes, apparently destroyed a considerable number of them. The technique of these experiments had to be worked out very carefully, and it has become evident to me that this important work has but little chance of success when it is carried out, as it was in this as well as in my previous attempts, as one out of several lines of investigation. In order to solve the problem, I believe that several investigators will have to devote the whole of their time to this work, for several months. Some observations were however made, which we consider of interest, although they are incomplete; they will be reported upon by Mrs. Summers-Connal, Dr. Connal and myself.

Towards the end of the work I inoculated an 'immune' individual (myself), i.e., an individual who had suffered from yellow fever previously, with blood from a yellow fever guinea-pig. The result was a somewhat doubtful reaction. Very slight rises of temperature were observed after several days, and a faint trace of albumen was found in the urine on two occasions. The pulse was irregular and the pulse-rate very low for a couple of weeks afterwards, in an individual, who, before and after that time, has been in good health and has never presented any symptom of cardiac or vascular disease.

It will be remembered that Thomas (1909) obtained similarly a slight reaction in an immune individual (himself) who was bitten by mosquitoes which had fed on infected guinea-pigs.

The results of these experiments naturally encourage one to consider the possibility of obtaining a method of vaccination against yellow fever. Dr. Connal and I did not consider ourselves authorised to undertake experiments on non-immune individuals without special permission from the Yellow Fever Commission, and thus we had no opportunity of proving that the virulence of the infection as regards human beings is reduced after a certain number of passages through guinea-pigs, but I feel very much inclined to that belief, especially in view of the well-known epidemiological experience, to which I have referred in various papers, that an outbreak of yellow fever in non-immunes usually starts with mild cases, as if the parasite were accustomed from its life in the 'immune' natives to produce only mild reactions,

after which it had to gain virulence by repeated passages through more favourable media. It is obvious that such a method of 'vaccination' would show a close analogy to the classical vaccination against small-pox.

In Nigeria as on the Gold Coast, the most ready and valuable assistance was rendered by all Colleagues and Government Officials concerned.

In addition to the yellow fever work, several other observations were made as the opportunity presented itself. Thus, we propose to report in separate papers our observations on the biology of *S. fasciata**, on the dissection of mosquitoes†, on malaria parasites in monkeys‡, on experiments with cresyl-fumigation¶, and on the effect of salvarsan-copper in experimental trypanosomiasis§.

As the chief results of the work here summarized I would mention:—

I. The carrying on of yellow fever infection through a practically unlimited number of guinea-pigs.

II. The demonstration of *P. flavigenum* in the blood and organs of the infected guinea-pigs, and the observation of hitherto unknown forms of the parasite.

III. The demonstration of certain elements—probably division forms of *P. flavigenum*—in infected mosquitoes.

IV. The demonstration of *P. flavigenum* in a number of cases observed in West Africa, some of which were clinically diagnosed as yellow fever, whilst others were considered doubtful. In the latter class I want to lay stress on the cases in children, in which a slight febrile reaction was the only symptom observed.

V. The improvement on the method of fumigation by means of cresyl.

The following I would consider the most important problems which present themselves for immediate investigation:—

* H. Seidelin and S. Summers-Connal. Notes upon the biology of *Stegomyia fasciata*. *Y. F. Bur. Bull.*, 1914, III, 3, pp. 187-192.

† H. Seidelin and S. Summers-Connal. A simple technique for the dissection and staining of mosquitoes. *Y. F. Bur. Bull.*, 1914, III, 3, pp. 193-197.

‡ H. Seidelin and A. Connal. A note upon the Occurrence of a *Plasmodium* in the blood of West African Monkeys. *Ann. Trop. Med. & Parasitol.*, Liverpool, 1914, VIII, 1, pp. 81-82.

¶ H. Seidelin. An apparatus for fumigation with cresyl. *Y. F. Bur. Bull.*, 1914, III, 3, pp. 209-213.

§ H. Seidelin. Experiments with salvarsan-copper in trypanosomiasis. *Ann. Trop. Med. & Parasitol.*, 1915, IX, 1, pp. 197-200.

I. The distribution of *P. flavigenum* in the various organs of animals experimentally infected by means of inoculation with emulsions of these organs.

II. With the knowledge thus acquired, investigation of the distribution of the parasite in the various human organs, when suitable opportunities present themselves at post-mortem examinations.

III. Transmission experiments with *S. fasciata* and other mosquitoes in order to determine which species of *Stegomyia* or perhaps even of other genera may be held responsible for the spread of yellow fever.

IV. Investigation of the parasite in infected mosquitoes, by microscopical examination and by injection into guinea-pigs of the contents of the various parts of the intestinal tract and of emulsions of salivary glands and other organs. Many details have to be investigated in this connection, especially with regard to the periods of infectiousness, and special attention will have to be paid to the genital glands in order to determine whether hereditary transmission of the infection from mosquitoes to their offspring exists.

V. Therapeutic experiments.

VI. Vaccination experiments, as outlined above.

EXPERIMENTAL YELLOW FEVER IN LABORATORY ANIMALS

BY

HARALD SEIDELIN, M.B. (Copenhagen), M.D. (Mexico), *Scientific Secretary, Yellow Fever Bureau, School of Tropical Medicine, University of Liverpool;* and ANDREW CONNAL, M.D., Ch.B. (Glas.), D.P.H., D.T.M. and H. (Cantab.), *West African Medical Staff, Director, Medical Research Institute, Yaba, Lagos, Nigeria.*

More or less successful experimental transmission of yellow fever to laboratory animals has been reported by Marchoux and Simond, Thomas, Seidelin, Macfie and Johnston.

Marchoux and Simond (1906) observed slight febrile reactions in chimpanzees which had been bitten by infected *Stegomyiae.*

Thomas (1907 and 1909) obtained febrile reactions and albuminuria in chimpanzees, and mild febrile reactions in rabbits and guinea-pigs. He experimented chiefly by means of infected mosquitoes, and to a less extent by means of injections of blood from yellow fever cases.

Seidelin (1912) injected guinea-pigs with blood taken from a yellow fever patient on the fifth day of illness, and containing *Paraplasma flavigenum.* He found the parasites in the blood of two of the injected animals, but no marked febrile reaction was observed. Another experiment with blood taken from a patient on the seventh day of illness gave a negative result.

Macfie and Johnston (1914) experimented* on guinea-pigs, dogs and rats. In guinea-pigs they obtained marked febrile reactions, and in some cases albuminuria, and in the blood they found '*Paraplasma*-like bodies.' In dogs and rats positive results were likewise obtained as far as the examination of the blood was

* Between June and September, 1913.

concerned, but a febrile reaction was observed in one rat only, and in none of the dogs.

In October, 1913, one of us obtained a strain of *P. flavigenum* from a yellow fever patient in Lagos, inoculating four guinea-pigs with blood drawn from a cubital vein. Since then we have carried on experiments with this strain, working mainly with guinea-pigs, which have been found very suitable. It is quite possible that some other animal might have shown more susceptibility to the infection, but none would have been so convenient for work on a large scale.

The guinea-pigs were carefully observed, records being kept of the temperatures and of the blood examinations, as well as of the post-mortem findings, with subsequent microscopical examinations.

The guinea-pigs showed great variations in the way in which they reacted, after infection.

They showed considerable rises of temperature in some cases, and occasionally marked remissions; in fact, some of the temperature charts might be taken for charts from yellow fever in the human. A sudden drop of the temperature occurred in several of these cases, after four to nine days; and in such cases death as a rule took place at this stage, the post-mortem examinations showing alterations typical of yellow fever. More or less marked, but rather irregular rises of temperature were observed in other cases, and death followed in one to two or three weeks after inoculation, a sudden drop of the temperature just before the fatal issue often occurring also in this group.

In other cases, again, recovery took place, which was, as far as one could judge, often final, but sometimes only apparent, death supervening one or two months after inoculation. Emaciation and albuminuria were the only abnormal conditions found post-mortem in these instances.

We shall now first give examples of what we would designate as typical cases:

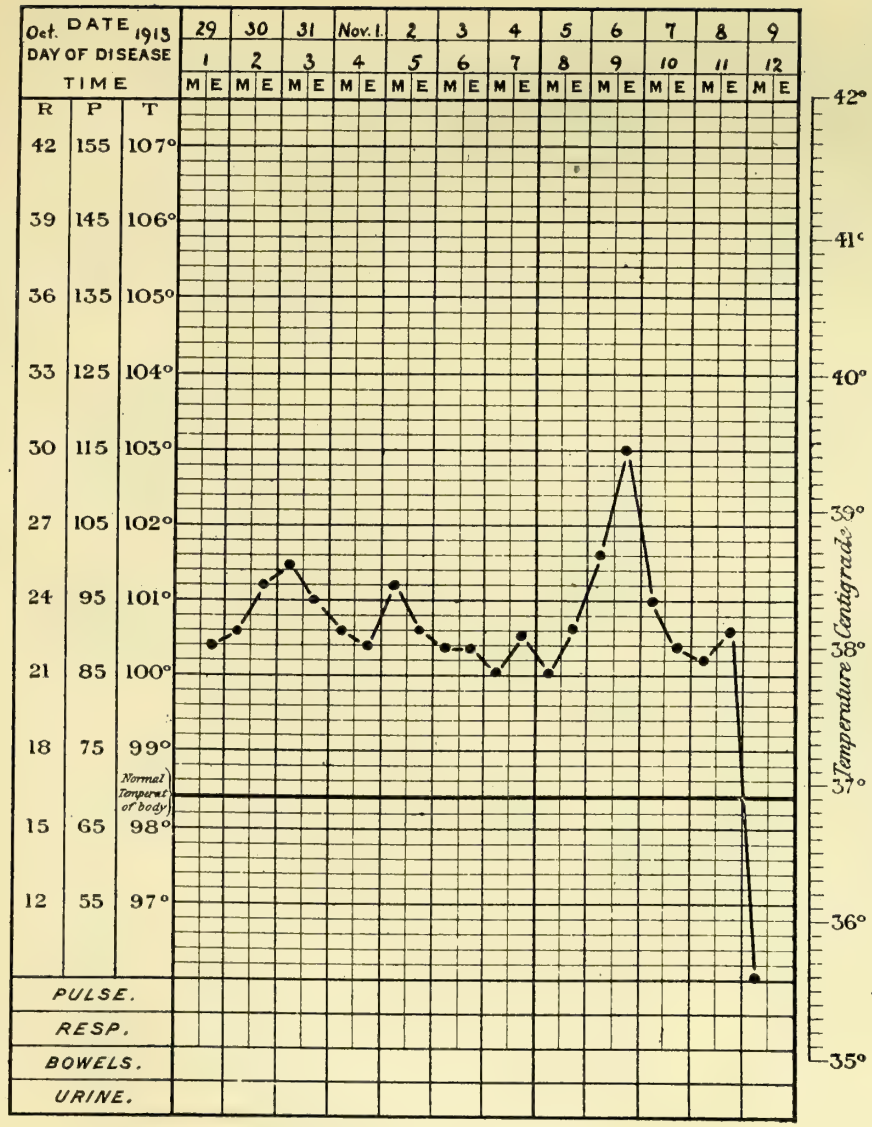

Chart 1.—G.-p. 170

Before inoculation: No parasites.
Parasites found: October 30, November 6 and 7.
Post-mortem examination.—Ecchymoses in stomach. Albumen in urine. Blue bodies in lung, spleen, liver, and bone-marrow.

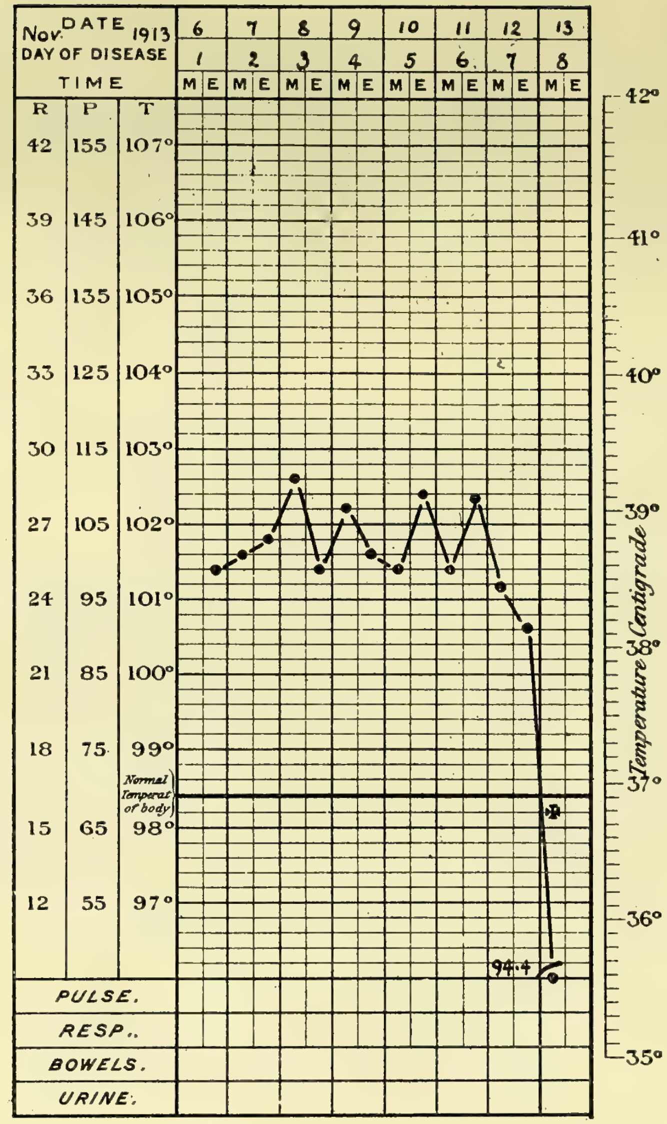

Chart 2.—G.-p. 175

Before inoculation: No parasites.
Parasites found: November 9 and 11.
Post-mortem examination.—Gastric petechiae. Albumen and casts in urine. Parasites in lung, spleen, and bone-marrow.

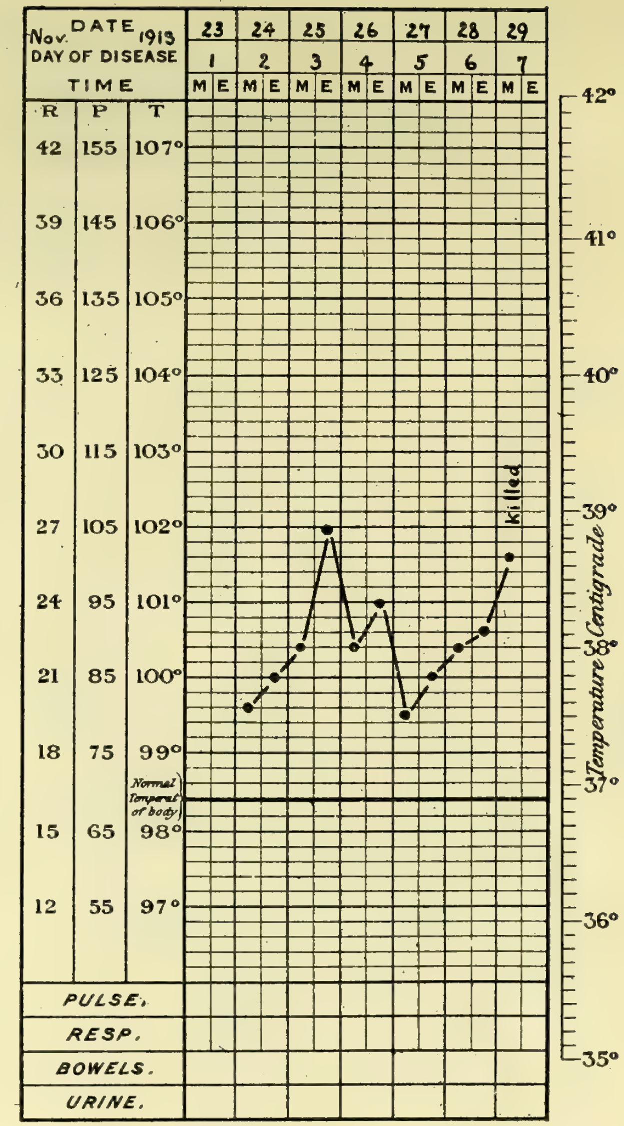

Chart 3.—G.-p. 210

Before inoculation: No parasites.
Parasites found: November 26.
Post-mortem examination.—Hyperaemia of stomach, liver and kidneys. Albumen in urine. Blue bodies found in lung, spleen, liver, kidney, and bone-marrow.

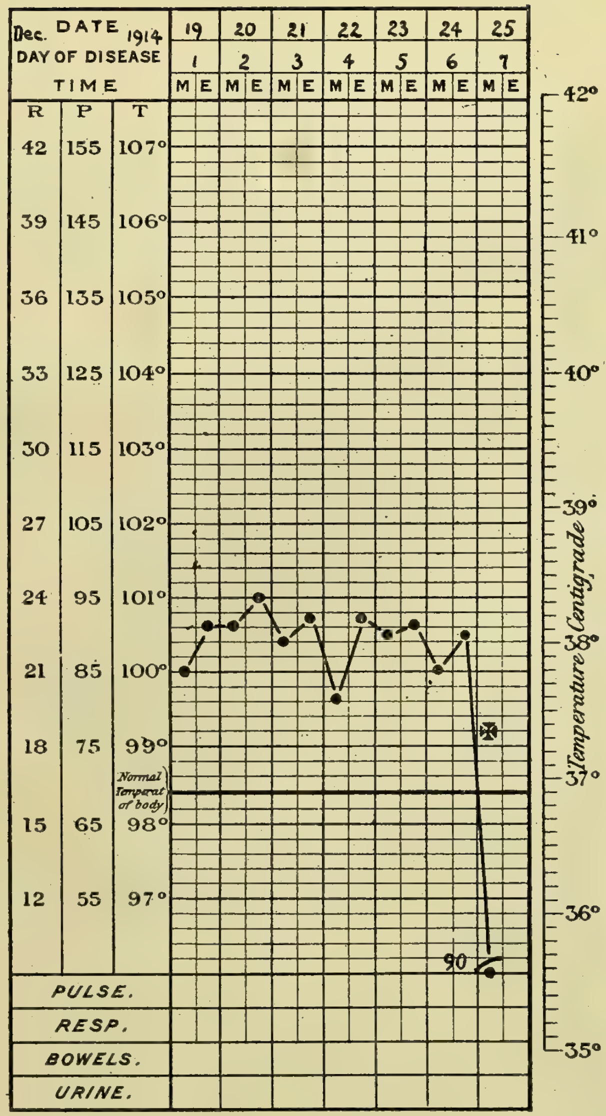

Chart 4.—G.-p. 258

Before inoculation: No parasites.
Parasites found: December 22.
Post-mortem examination.—Ecchymoses and erosions in stomach. Albumen in urine. Blue bodies in spleen and bone-marrow, none in lung and liver.

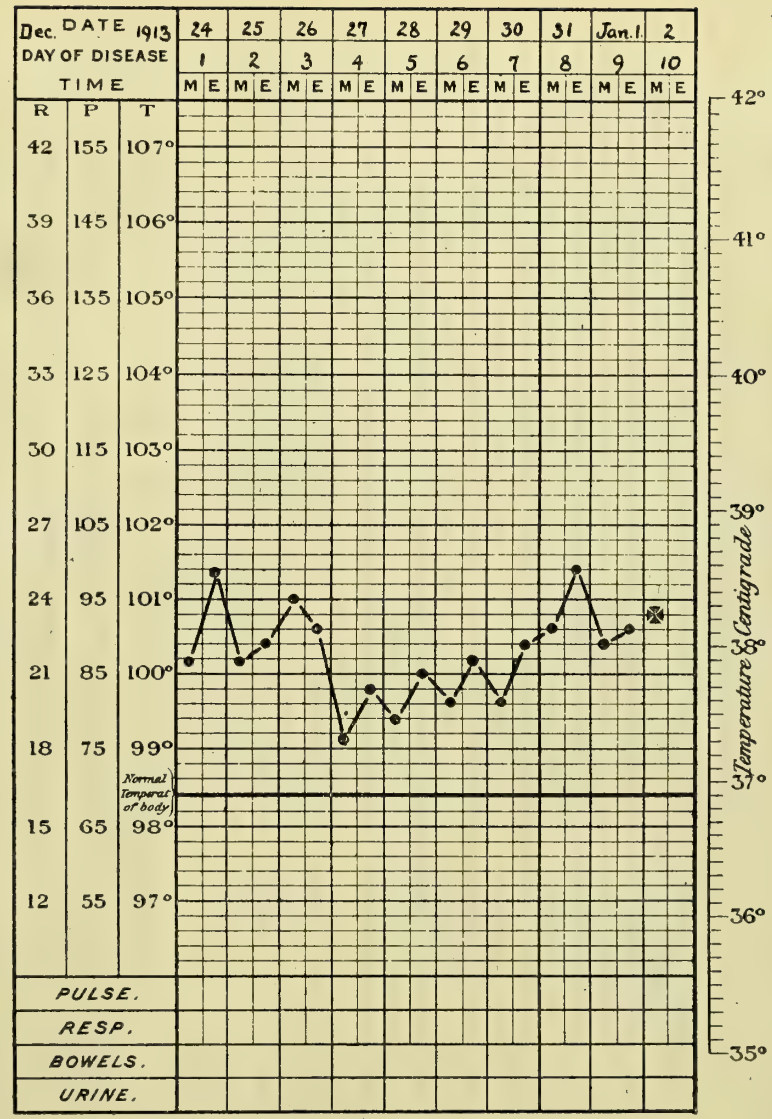

Chart 5.—G.p. 274

Before inoculation: No parasites.
Parasites not found before death.
Post-mortem examination.—Ecchymoses and erosions in stomach. Albumen in urine. *P. flavigenum* in lung, blue bodies in spleen.

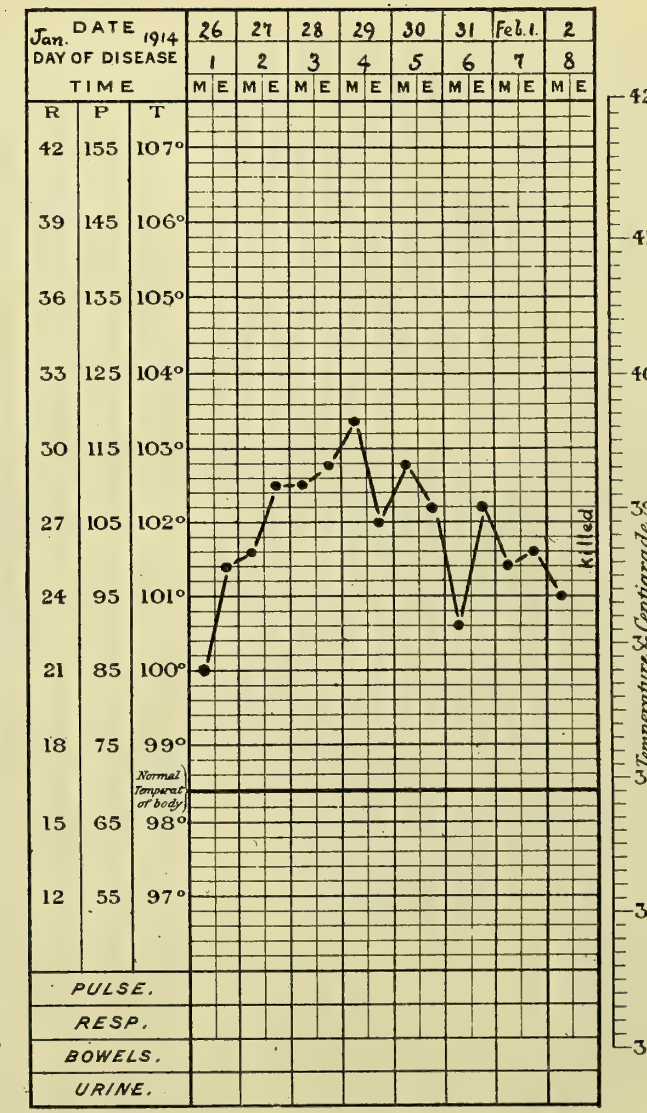

Chart 6.—G.-p. 340

Before inoculation: No parasites.
Parasites found: January 28.
Post-mortem examination.—Gastric hyperaemia and petechiae. Albumen in urine (intense reaction). No blue bodies.

Some cases showed a hyperacute course, death resulting a few days after the injection. It is remarkable that in several of these, gastric hyperaemia or ecchymoses were marked whilst albuminuria was absent. Apparently the kidney affection had not had sufficient time to develop, a phenomenon which is not without its parallel in yellow fever in the human, in which the kidneys often are affected only to a comparatively slight degree when death takes place at an early stage of the disease. Such cases are the following:

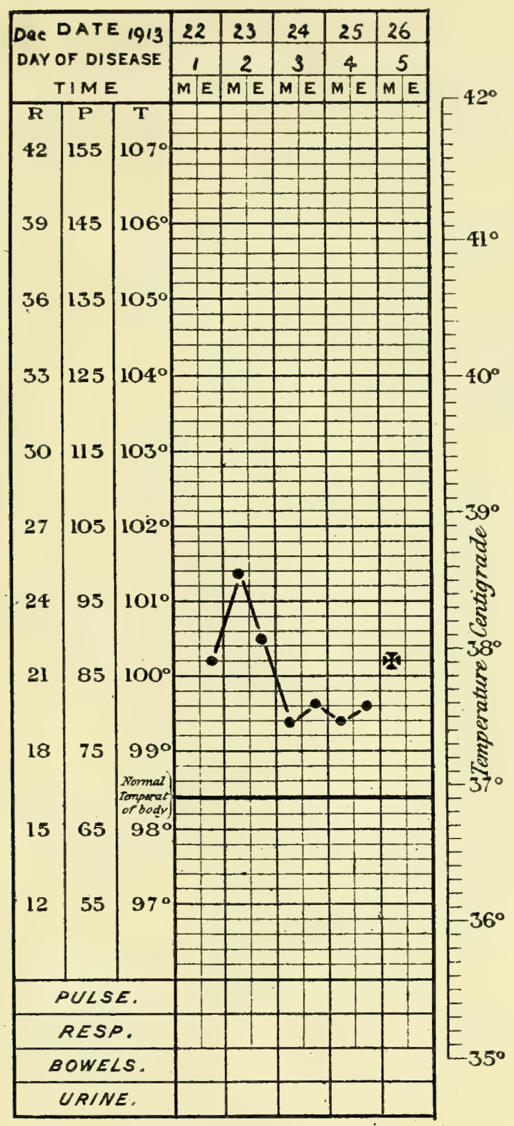

Chart 7.—G.-p. 269

Before inoculation: No parasites.
Parasites not found before death (blood not examined after inoculation).
Post-mortem examination.—Gastric hyperaemia. No albumen in urine. *P. flavigenum* in heart-blood and lung. Blue bodies in spleen and liver, none in bone-marrow.

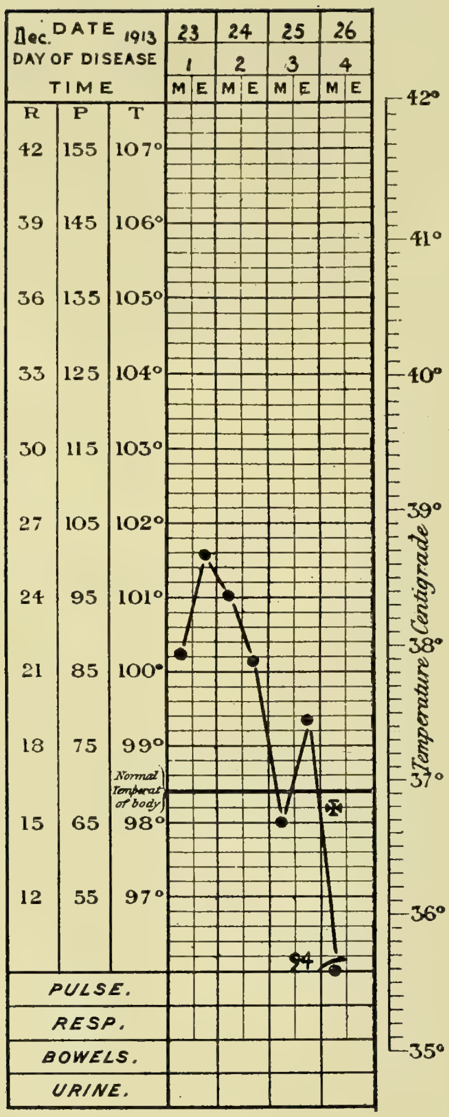

Chart 8.—G.-p. 272

Before inoculation: No parasites.
Parasites found: December 25.
Post-mortem examination.—Gastric petechiae. No albumen in urine. No blue bodies.

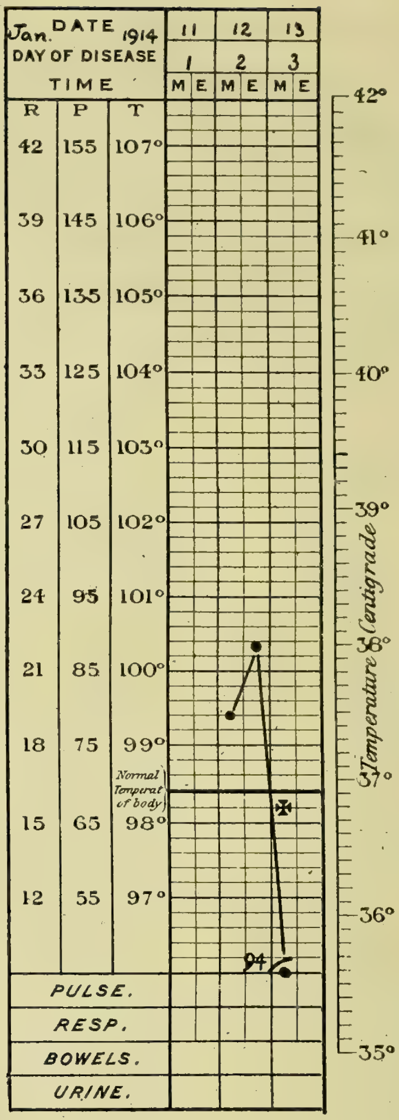

Chart 9.—G.-p. 314

Before inoculation: No parasites.
Parasites not found before death (blood not examined after inoculation).
Post-mortem examination.—Haemorrhagic erosions in stomach. No albumen in urine. Blue bodies in lung, spleen, and liver.

On the other hand, there were examples which, although ending fatally, showed a prolonged course; and here it would appear that the animal had recovered from the acute disease, as an expression of which gastric lesions were absent or but of a slight nature, whilst the albuminuria had persisted and perhaps was the cause of the fatal termination. The following are examples of cases in which death took place at a late stage of the disease:

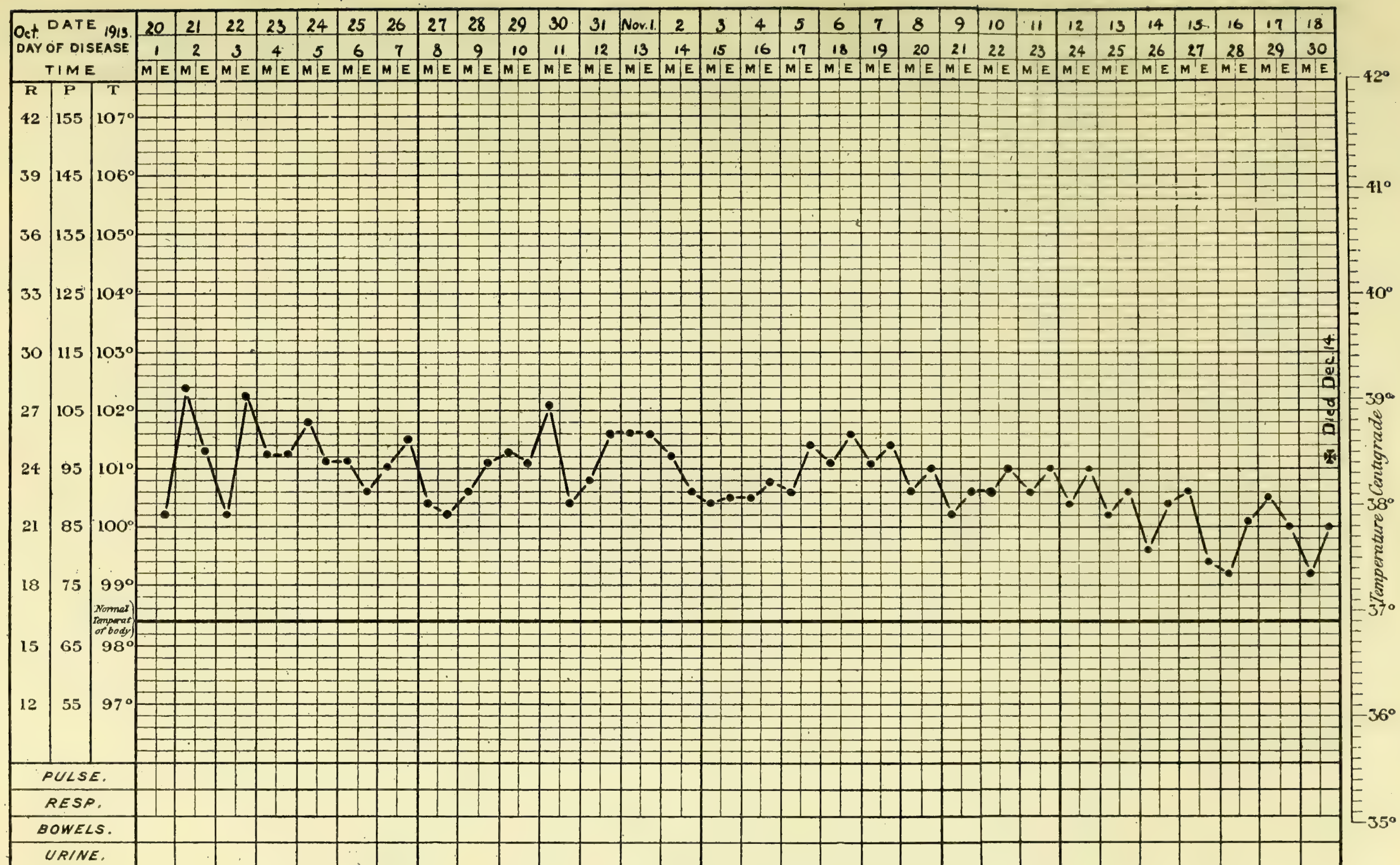

Chart 10.—G.-p. 150

Before inoculation: No parasites.
Parasites found: October 22, 23, 24, 25, November 2.
Post-mortem examination: Gastric hyperaemia. Albuminuria. *P. flavigenum* in lung, blue bodies in spleen.

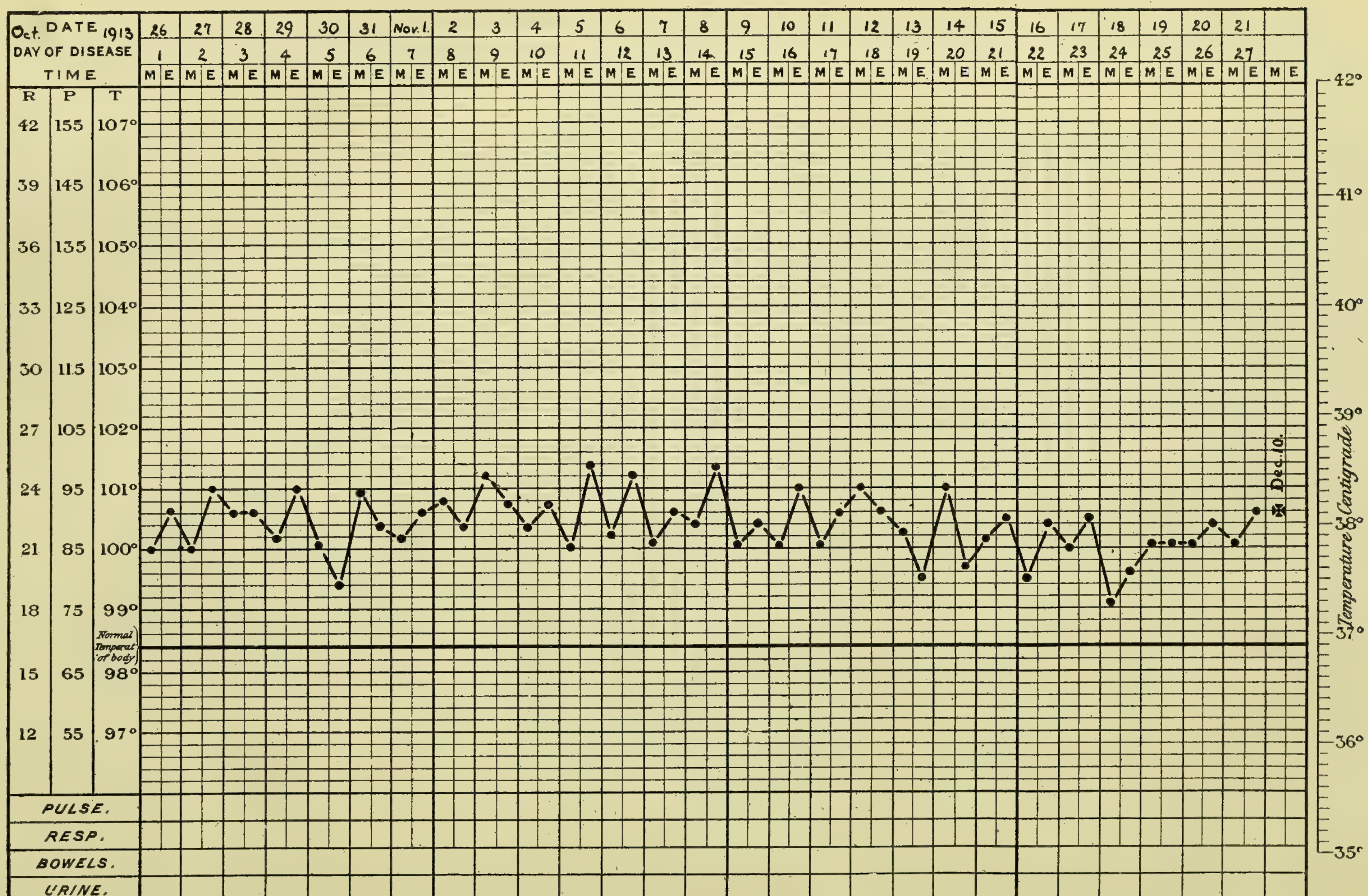

Chart 11.—G.-p. 155

Before inoculation : No parasites.
Parasites found : October 30, November 1, 2.
Post-mortem examination : Albumen in urine (faint reaction) ; no other pathological phenomena. Blue bodies in lung, spleen, and bone-marrow.

Some other guinea-pigs died several weeks after inoculation, showing neither gastric lesions nor albuminuria. Thus they had apparently recovered completely from ihe infection. No cause of death could be demonstrated. The following is an example of this group of cases:

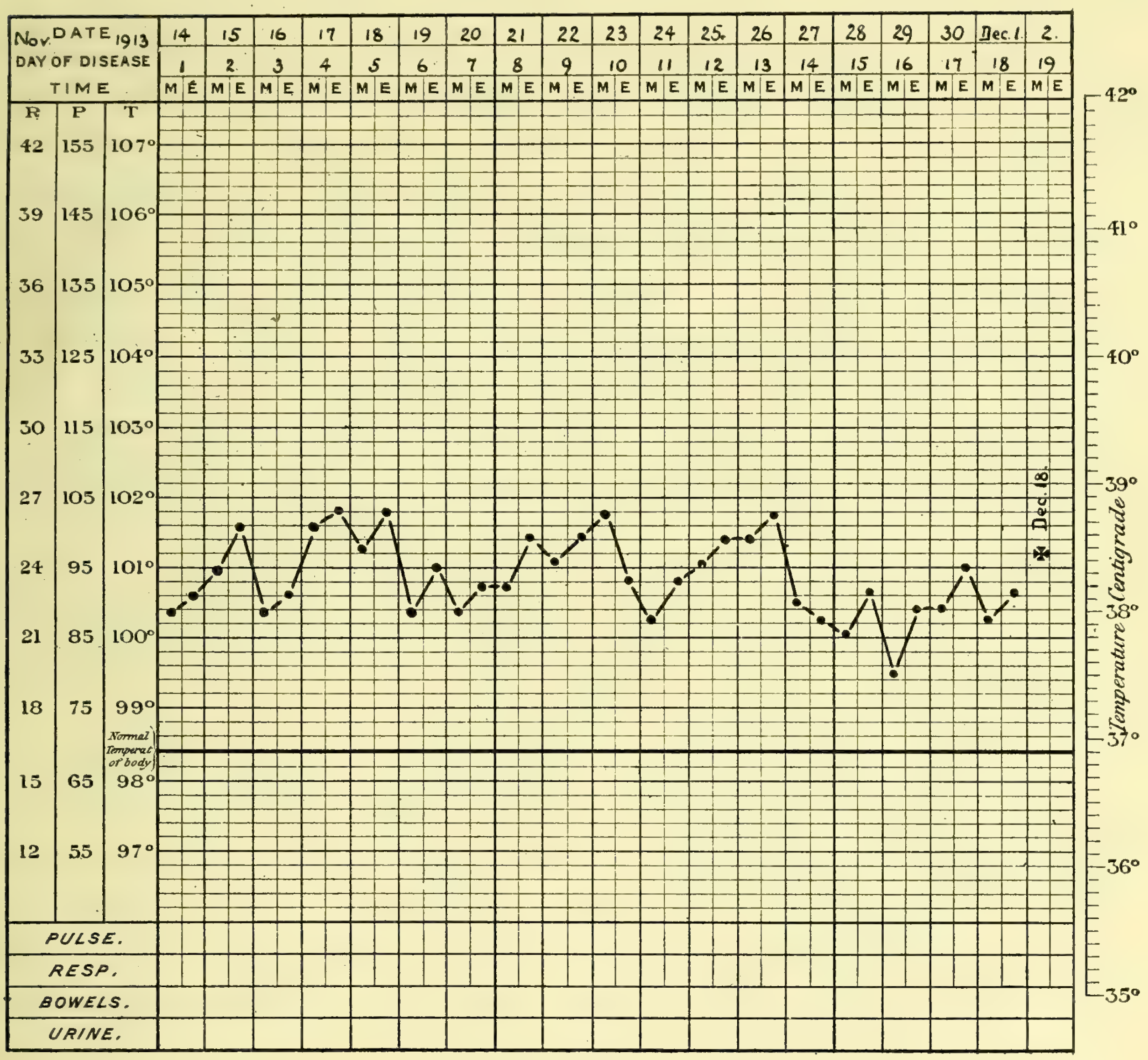

Chart 12.—G.-p. 191

Before inoculation: No parasites.
Parasites found: November 16, 18, 22.
Post-mortem examination.—No lesions. No parasites in lung and spleen.

We have no conclusive proof that the affection has run a course as here outlined for the latter groups, but in support of our view we might mention that many animals were killed about a week or ten days after infection, and that in nearly all such animals, marked lesions—hyperaemia, ecchymoses, or haemorrhagic erosions of the gastric mucosa—were observed.

The total number of guinea-pigs experimented upon was 112. In addition, three monkeys were inoculated.

Four guinea-pigs were injected on 4th October, 1913, from the patient No. L. 69*, and four others on October 15th from the patient No. L. 73† of the Nigeria cases studied under the Yellow Fever Commission. The former patient was under the care of Dr. T. M. R. Leonard in the Lagos Hospital; he was on the fourth day of illness when the experiment was made, the temperature having dropped from 38·9° C. (102° F.) on the previous night, to below the normal. The latter patient was also observed in the Hospital in Lagos. At the time of withdrawing the blood he was on the third day of the disease, and his temperature was about 40° C. (104° F.). The blood was withdrawn, in each case, from a vein in the cubital fold, and was mixed in the syringe with a sterilised 1 per cent. solution of sodium citrate (7 c.c. of blood to 3 c.c. of citrate solution). Two animals were injected intraperitoneally and two subcutaneously from each patient. The quantity of blood injected varied from 0·35 c.c. to 3·5 c.c.

An uninterrupted series of infections was carried on from one of these animals inoculated intraperitoneally from Case L. 73. At the end of January, 1914, twenty-three animals had thus been infected consecutively, as shown in the adjoining Table I (Series S). From one of the guinea-pigs in this series another series was carried on which is summarised in Table II (Series C). Additional animals were infected from time to time, or minor series continued for different periods, for special purposes, or in order to have material to fall back upon should the infection die out in the principal series. Indirect transmission is discussed in a later section (p. 455, Table IV). Reinoculations are not dealt with in this paper.

A summary of all the experimental infections is given in Table III.

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* *Vide* Dr. Leonard's report (vol. I, p. 268).

† *Ibid.* (vol. I, p. 270).

TABLE I.

Dr. Seidelin's Series.

(r)—Reinoculation.

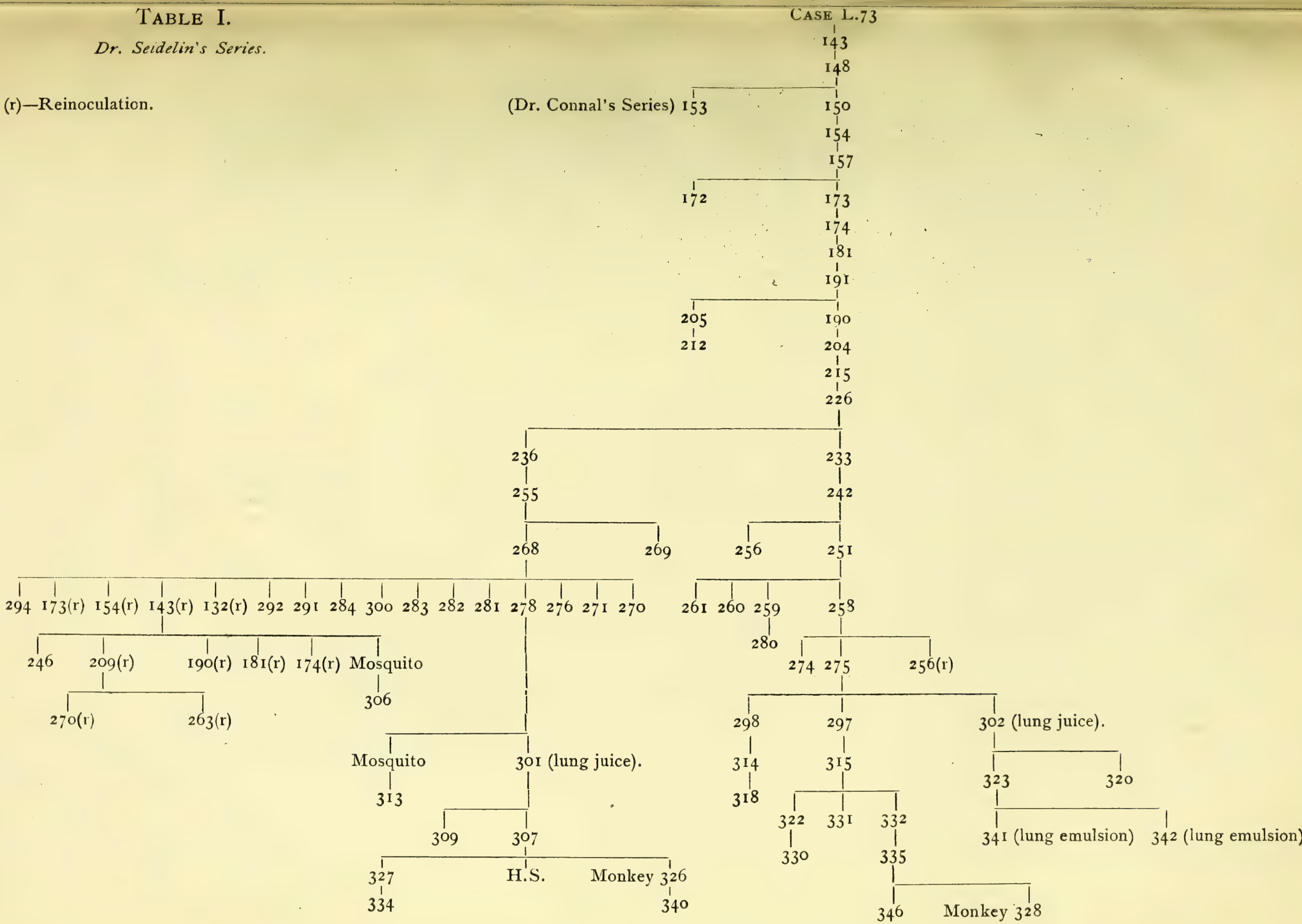

TABLE II.

Dr. Connal's Series.

(r)—Reinoculation.
Con.—Convalescent from previous inoculation; after some time the convalescents were kept together in a mosquito-proof house, isolated from the other guinea-pigs, but not in separate cages. Consequently they could not be identified by their previous numbers.

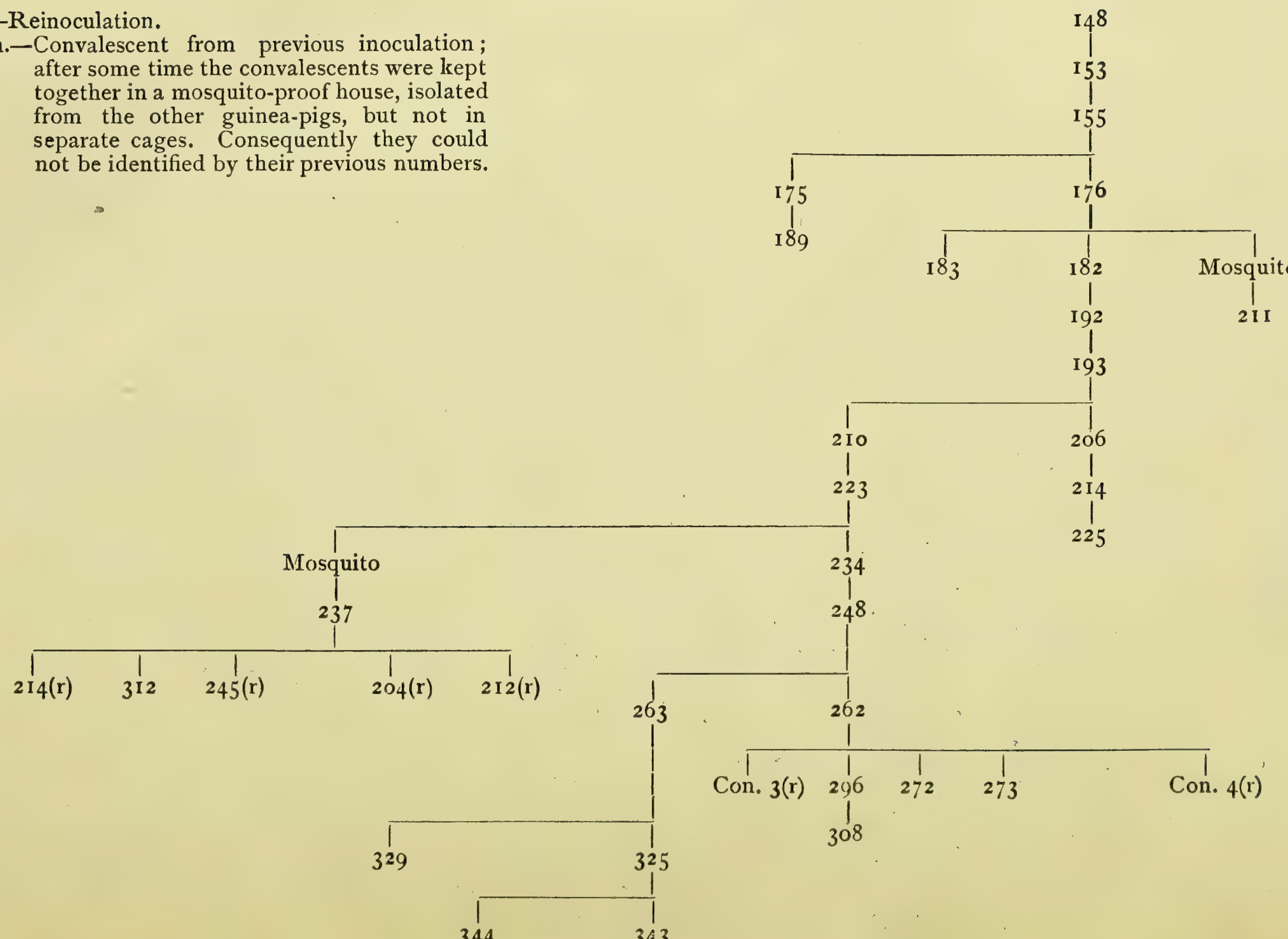

Table III

Transmission by Direct Injection

Exp. No.	Date	Animal No.	Inoculated from	Number of days after inoculation of animal from which inoculated	Material and amount inoculated (in c.c.)	Method of Inoculation	Highest temperature recorded (Centigrade)	Parasites first found — days after inoculation	Death (spont.) — days after inoculation	Killed — days after inoculation	Alive (observed — days after inoculation)	Stomach			Fat in		Alb. in Urine	*P. flavigenum*				Blue bodies				Remarks
												Hyperaemia	Haemorrhages	Erosions	Liver	Kidney		Lung	Spleen	Bone-marrow	Liver	Lung	Spleen	Bone-marrow	Liver	
1	4-X-13	G.-p. 130	Human case L.67	5th day of illness	V.b. 1·4	P.	39·0	3	...	...	19	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Dismissed
2	4-X-13	G.-p. 131	Human case L.67	5th day of illness	V.b. 3·5	P.	39·0	5	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
3	4-X-13	G.-p. 132	Human case L.67	5th day of illness	V.b. 0·7	C.	38·7	3	...	...	86	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Reinoculated
4	4-X-13	G.-p. 133	Human case L.67	5th day of illness	V.b. 1·4	C.	39·0	4	...	...	19	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Dismissed
5	10-X-13	G.-p. 134	Indirectly G.-p. 132	6	Blood-culture 0·15	S.C.	39·4	2	...	...	14	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Dismissed
6	13-X-13	G.-p. 140	G.-p. 134	3	V.b. 0·1	S.C.	38·9	1	...	...	11	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Dismissed
7	15-X-13	G.-p. 141	Human case L.73	3rd day of illness	V.b. 0·7	P.	39·0	7	8	...	...	—	—	—	...	...	—	...	—	—	+	...	...	...	...	Death
8	15-X-13	G.-p. 142	Human case L.73	3rd day of illness	V.b. 0·5	C.	39·0	3	...	...	9	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Dismissed
9	15-X-13	G.-p. 143	Human case L.73	3rd day of illness	V.b. 0·5	P.	39·0	3	...	...	75	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Reinoculated
10	15-X-13	G.-p. 144	Human case L.73	3rd day of illness	V.b. 1·0	C.	38·9	—	...	...	8	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Dismissed, negative

V.b.—Venous blood, if from human, drawn from arm vein; if from monkey, from femoral vein; if from guinea-pig, from cavernous sinus. H.b.—Heart-blood. S.—Filtered serum. L.j.—Lung-juice. L.e.—Lung emulsion. P.—Intraperitoneal. C.—Subcutaneous. S.C.—Sinus cavernosus. P.-m.—Post-mortem examination.

TABLE III—*continued*

Exp. No.	Date	Animal No.	Inoculated from	Number of days after inoculation of animal from which inoculated	Material and amount inoculated (in c.c.)	Method of Inoculation	Highest temperature recorded (Centigrade)	Parasites first found — days after inoculation	Death (spont.) — days after inoculation	Killed — days after inoculation	Alive (observed — days after inoculation)	Stomach: Hyperaemia	Stomach: Haemorrhages	Stomach: Erosions	Fat in: Liver	Fat in: Kidney	Alb. in Urine	*P. flavigenum*: Lung	*P. flavigenum*: Spleen	*P. flavigenum*: Bone-marrow	*P. flavigenum*: Liver	Blue bodies: Lung	Blue bodies: Spleen	Blue bodies: Bone-marrow	Blue bodies: Liver	Remarks
12	18-X-13	G.-p. 147	G.-p. 140	5	V.b. 0·1	C.	38·8	2	11	...	...	+	...	...	+	...	+	...	?	...	−	...	...	...	...	Death
13	18-X-13	G.-p. 148	G.-p. 143	3	V.b. 0·2	C.	38·9	2	...	...	74	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Reinoculated
14	20-X-13	G.-p. 150	G.-p. 148	2	V.b. 0·2	C.	39·1	3	55	...	...	+	−	−	...	...	+	+	−	...	...	−	+	...	...	Death
15	23-X-13	G.-p. 153	G.-p. 148	5	V.b. 0·1	C.	38·2	2	4	...	...	+	+	−	...	...	...	...	+	...	+	...	...	...	...	Death
16	23-X-13	G.-p. 154	G.-p. 150	3	V.b. 0·1	C.	38·9	3	...	...	67	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Reinoculated
19	27-X-13	G.-p. 155	G.-p. 153	4	H.b. 0·05	P.	38·6	5	26	...	...	−	−	−	...	...	+	−	−	−	−	+	−	+	−	Death
20	27-X-13	G.-p. 157	G.-p. 154	4	V.b. 0·1	P.	38·6	4	...	...	66	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Reinoculated
21	29-X-13	G.-p. 170	G.-p. 147	11	V.b. 0·1	C.	39·4	2	12	...	...	−	+	−	...	...	+	+	+	+	+	...	...	...	...	Death
22	31-X-13	G.-p. 172	G.-p. 157	4	V.b. 0·15	C.	39·2	2	9	...	...	−	−	−	...	...	+	−	+	+	+	...	...	...	...	Death
23	31-X-13	G.-p. 173	G.-p. 157	4	V.b. 0·15	C.	39·5	2	...	...	60	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Reinoculated
25	4-XI-13	G.-p. 174	G.-p. 173	4	V.b. 0·2	C.	39·3	9	...	...	63	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Reinoculated
27	6-XI-13	G.-p. 175	G.-p. 155	10	V.b. 0·1	P.	39·2	4	7	...	...	−	+	−	...	...	+ & casts	+	+	+	...	...	...	...	...	Death

V.b.—Venous blood, if from human, drawn from arm vein; if from monkey, from femoral vein; if from guinea-pig, from cavernous sinus. H.b.—Heart-blood. S.—Filtered serum. L.j.—Lung-juice. L.e.—Lung emulsion. P.—Intraperitoneal. C.—Subcutaneous. S.C.—Sinus cavernosus. P.-m.—Post-mortem examination.

TABLE III—*continued*

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28	6-XI-13	G.-p. 176	G.-p. 155	10	V.b. 0·1	C.	39·2	3	...	...	17	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Dismissed
30	9-XI-13	G.-p. 178	G.-p. 170	11	V.b. 0·05	P.	39·5	3	...	...	14	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Dismissed
31	9-XI-13	G.-p. 179	G.-p. 170	11	H.b. 0·2	P.	38·9	3	...	...	14	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Dismissed
32	10-XI-13	G.-p. 182	G.-p. 176	4	V.b. 0·1	C.	39·2	—	...	...	14	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Dismissed, negative
33	10-XI-13	G.-p. 183	G.-p. 176	4	V.b. 0·1	P.	39·1	3	...	...	14	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Dismissed
35	10-XI-13	G.-p. 181	G.-p. 174	6	V.b. 0·2	P.	39·4	3	...	...	57	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Reinoculated
39	12-XI-13	G.-p. 186	G.-p. 178	3	V.b. 0·1	C.	39·6	7	...	...	20	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Dismissed
40	12-XI-13	G.-p. 187	G.-p. 178	3	V.b. 0·05	P.	38·9	9	...	...	20	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Dismissed
42	13-XI-13	G.-p. 189	G.-p. 175	7	H.b. 0·3	P.	38·9	10	...	...	19	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Dismissed
43	14-XI-13	G.-p. 191	G.-p. 181	4	V.b. 0·1	P.	38·7	3	34	...	...	—	—	—	...	...	—	—	—	...	...	—	—	...	...	Death
44	14-XI-13	G.-p. 192	G.-p. 182	4	V.b. 0·2	C.	38·9	3	...	...	18	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Dismissed
46	18-XI-13	G.-p. 193	G.-p. 192	4	V.b. 0·2	C.	38·5	? 4	5	...	...	+	—	—	...	...	+	+	—	...	+	...	...	...	...	Death

V.b.—Venous blood, if from human, drawn from arm vein; if from monkey, from femoral vein; if from guinea-pig, from cavernous sinus. H.b.—Heart-blood. S.—Filtered serum. L.j.—Lung-juice. L.e.—Lung emulsion. P.—Intraperitoneal. C.—Subcutaneous. S.C.—Sinus cavernosus. P.-m.—Post-mortem examination.

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Exp. No.	Date	Animal No.	Inoculated from	Number of days after inoculation of animal from which inoculated	Material and amount inoculated (in c.c.)	Method of Inoculation	Highest temperature recorded (Centigrade)	Parasites first found — days after inoculation	Death (spont.) — days after inoculation	Killed — days after inoculation	Alive (observed — days after inoculation)	Stomach: Hyperaemia	Stomach: Haemorrhages	Stomach: Erosions	Fat in: Liver	Fat in: Kidney	Alb. in Urine	*P. flavigenum*: Lung	*P. flavigenum*: Spleen	*P. flavigenum*: Bone-marrow	*P. flavigenum*: Liver	Blue bodies: Lung	Blue bodies: Spleen	Blue bodies: Bone-marrow	Blue bodies: Liver	Remarks
47	18-XI-13	G.-p. 190	G.-p. 191	4	V.b. 0·1	P.	38·8	3	...	...	49	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Reinoculated
52	22-XI-13	G.-p. 204	G.-p. 190	4	V.b. 0·2	P.	39·4	5	...	...	51	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Reinoculated
53	22-XI-13	G.-p. 205	G.-p. 191	8	V.b. 0·2	P.	38·4	? 2	3	...	...	...	+	+	...	...	+	+	+	+	−	...	...	...	...	Death
54	22-XI-13	G.-p. 206	G.-p. 193	4	V.b. 0·1	C.	38·8	—	...	54	...	+	+	+	...	...	−	−	...	...	...	−	+	...	...	Death
57	23-XI-13	G.-p. 210	G.-p. 193	5	H.b. 0·1	P.	38·9	4	...	6	...	+	−	−	...	...	+	+	+	+	+	+	+	...	+	Death
58	25-XI-13	G.-p. 212	G.-p. 205	3	H.b. 0·1	P.	38·8	10	...	...	47	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Reinoculated
60	26-XI-13	G.-p. 214	G.-p. 206	4	V.b. 0·1	C.	38·9	3	...	...	47	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Reinoculated
61	26-XI-13	G.-p. 215	G.-p. 204	4	V.b. 0·05	P.	39·2	9	33	...	...	De	com	pose	d	...	...	...	...	...	...	...	...	...	...	Death
68	29-XI-13	G.-p. 223	G.-p. 210	6	H.b. 0·1	P.	39·1	3	...	7	...	−	−	−	...	...	−	+	−	+	+	...	...	...	...	Death
70	1-XII-13	G.-p. 225	G.-p. 214	5	V.b. 0·1	C.	38·7	4	...	...	45	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Reinoculated
71	1-XII-13	G.-p. 226	G.-p. 215	5	V.b. 0·2	P.	38·8	4	...	6	...	−	−	−	−	...	−	+	−	−	+	...	...	...	...	Death
73	4-XII-13	G.-p. 233	G.-p. 226	3	V.b. 0·2	P.	38·5	5	...	5	...	−	−	−	...	−	+	−	?	?	?	...	...	...	...	Death

V.b.—Venous blood, if from human, drawn from arm vein; if from monkey, from femoral vein; if from guinea-pig, from cavernous sinus. H.b.—Heart-blood. S.—Filtered serum. L.j.—Lung-juice. L.e.—Lung emulsion. P.—Intraperitoneal. C.—Subcutaneous. S.C.—Sinus cavernosus. P.-m.—Post-mortem examination.

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Exp. No.	Date	Animal No.	Inoculated from	Number of days after inoculation of animal from which inoculated	Material and amount inoculated (in c.c.)	Method of Inoculation	Highest temperature recorded (Centigrade)	Parasites first found — days after inoculation	Death (spont.) — days after inoculation	Killed — days after inoculation	Alive (observed — days after inoculation)	Stomach: Hyperaemia	Stomach: Haemorrhages	Stomach: Erosions	Fat in: Liver	Fat in: Kidney	Alb. in Urine	*P. flavigenum*: Lung	*P. flavigenum*: Spleen	*P. flavigenum*: Bone-marrow	*P. flavigenum*: Liver	Blue bodies: Lung	Blue bodies: Spleen	Blue bodies: Bone-marrow	Blue bodies: Liver	Remarks
76	6-XII-13	G.-p. 234	G.-p. 223	7	H.b. 0·4	P.	38·5	3	...	5	...	–	–	–	...	...	...	+	...	–	+	...	...	...	...	Death
79	7-XII-13	G.-p. 236	G.-p. 226	6	H.b. 1·0	P.	39·4	1	...	8	...	–	+	–	...	...	...	+	...	...	–	...	...	...	...	Death
81	9-XII-13	G.-p. 242	G.-p. 233	5	H.b. 1·0	P.	38·3	3	...	6	...	...	+	–	...	...	+	+	+	...	...	...	...	...	...	Death
84	11-XII-13	G.-p. 248	G.-p. 234	5	H.b. 1·0	P.	38·9	3	...	10	...	...	–	+	...	...	...	–	...	–	?	...	+	...	...	Death
86	13-XII-13	G.-p. 251	G.-p. 242	4	V.b. 0·5	P.	38·0	4	...	6	...	...	–	+	...	...	...	...	...	...	...	+	...	+	...	Death
91	15-XII-13	G.-p. 255	G.-p. 236	8	H.b. 1·0	P.	38·3	3	...	7	...	...	+	–	...	...	...	...	...	...	...	+	+	–	+	Death
92	15-XII-13	G.-p. 256	G.-p. 242	6	H.b. 1·0	P.	38·1	3	...	...	9	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Reinoculated
97	19-XII-13	G.-p. 258	G.-p. 251	6	H.b. 1·0	P.	38·3	4	6	...	...	...	+	+	...	...	+	–	...	...	–	...	+	+	–	Death
98	19-XII-13	G.-p. 259	G.-p. 251	6	H.b. 1·0	P.	39·1	4	...	7	...	–	–	–	...	...	...	+	–	–	–	–	–	+	–	Death
99	19-XII-13	G.-p. 260	G.-p. 251	6	S. 0·1	P.	38·4	35	...	40	...	–	–	–	...	...	+	–	...	...	...	–	+	...	...	Death
100	19-XII-13	G.-p. 261	G.-p. 251	6	S. 1·2	P.	38·4	26	...	34	...	–	–	–	...	...	? –	–	...	...	...	–	+	...	...	Death
101	20-XII-13	G.-p. 262	G.-p. 248	9	V.b. 0·1	C.	38·9	2	25	...	...	+	+	...	...	...	–	...	...	...	...	...	+	...	+	Death
102	20-XII-13	G.-p. 263	G.-p. 248	9	V.b. 0·1	C.	38·4	3	1	...	24	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Reinoculated

V.b.—Venous blood, if from human, drawn from arm vein; if from monkey, from femoral vein; if from guinea-pig, from cavernous sinus. H.b.—Heart-blood.
S.—Filtered serum. L.j.—Lung-juice. L.e.—Lung emulsion. P.—Intraperitoneal. C.—Subcutaneous. S.C.—Sinus cavernosus. P.-m.—Post-mortem examination.

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103	21-XII-13	G.-p. 264	G.-p. 248	10	H.b. 1·0	P.	38·3	9	...	...	24	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Reinoculated
104	22-XII-13	G.-p. 268	G.-p. 255	7	H.b. 0·5	P.	39·0	2	...	...	19	+	−	−	...	...	−	...	...	...	...	+	+	−	+	Death
105	22-XII-13	G.-p. 269	G.-p. 255	7	H.b. 0·5	P.	38·4	H.b. at p.-m.	4	...	...	+	−	−	...	...	−	+	...	−	...	...	+	...	+	Death
112	23-XII-13	G.-p. 272	G.-p. 262	3	V.b. 0·05	P.	38·5	2	3	...	...	−	+	−	...	...	...	−	−	−	−	−	...	...	...	Death
113	23-XII-13	G.-p. 273	G.-p. 262	3	V.b. 0·05	P.	38·2	7	...	...	21	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Reinoculated
114	23-XII-13	G.-p. 270	G.-p. 268	1	V.b. 0·2	P.	38·3	2	...	...	20	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Reinoculated
115	24-XII-13	G.-p. 271	G.-p. 268	2	V.b. 0·2	P.	38·3	—	22	...	...	−	−	−	...	...	−	−	−	...	...	−	−	...	...	Death, negative
117	24-XII-13	G.-p. 274	G.-p. 258	5	V.b. 0·1	P.	38·4	—	9	...	...	...	+	+	...	...	+	+	...	...	+	...	+	...	+	Death
118	25-XII-13	G.-p. 275	G.-p. 258	6	H.b. 0·5	P.	38·8	5	13	...	...	+	−	+	...	...	+	−	−	−	+	−	−	−	−	Death
119	25-XII-13	G.-p. 276	G.-p. 268	3	V.b. 0·2	P.	38·4	2	...	...	20	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Reinoculated
123	26-XII-13	G.-p. 280	G.-p. 259	7	H.b. 0·5	P.	38·3	2	...	20	...	−	+	−	...	...	+	+	−	...	...	+	−	...	...	Death
124	27-XII-13	G.-p. 278	G.-p. 268	5	V.b. 0·2	P.	38·7	2	7	...	...	+	+	−	...	...	+	+	−	−	+	−	+	−	+	Death
126	28-XII-13	G.-p. 281	G.-p. 268	6	V.b. 0·2	P.	38·3	2	...	25	...	−	−	−	...	...	...	+	+	...	...	−	+	...	...	Death

V.b.—Venous blood, if from human, drawn from arm vein; if from monkey, from femoral vein; if from guinea-pig, from cavernous sinus. H.b.—Heart-blood. S.—Filtered serum. L.j.—Lung-juice. L.e.—Lung emulsion. P.—Intraperitoneal. C.—Subcutaneous. S.C.—Sinus cavernosus. P.-m.—Post-mortem examination.

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127	29-XII-13	G.-p. 282	G.-p. 268	7	V.b. 0·2	P.	38·5	H.b. at p.-m.	5	...	...	+	−	−	...	...	+	−	−	−	−	...	...	...	...	Death
128	30-XII-13	G.-p. 283	G.-p. 268	8	V.b. 0·1	P.	38·4	5	...	11	...	+	+	−	...	...	...	−	−	−	−	+	+	...	+	Death
129	30-XII-13	G.-p. 284	G.-p. 268	8	V.b. 0·1	P.	38·4	5	...	16	...	−	−	−	...	...	−	−	−	...	...	−	−	...	...	Death
130	30-XII-13	G.-p. 291	G.-p. 268	8	V.b. 0·2	P.	38·1	2	...	...	15	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Reinoculated
131	30-XII-13	G.-p. 292	G.-p. 268	8	V.b. 0·2	P.	38·9	—	2	...	...	−	−	−	...	...	−	−	−	...	−	...	...	+	...	Death
140	31-XII-13	G.-p. 300	G.-p. 268	9	V.b. 0·2	P.	38·3	4	14	...	...	−	+	+	...	...	...	...	...	...	...	+	+	...	+	Death
141	1-I-14	G.-p. 294	G.-p. 268	10	V.b. 0·2	P.	38·5	3	...	22	...	−	−	−	...	...	−	−	...	...	...	−	+	...	...	Death
142	3-I-14	G.-p. 296	G.-p. 262	14	V.b. 0·2	C.	38·7	2	...	7	...	−	−	−	...	...	−	+	−	+	−	?	+	+	?	Death
143	3-I-14	G.-p. 297	G.-p. 275	9	V.b. 0·2	P.	38·9	12	14	...	...	−	+	+	...	...	+	...	...	−	...	+	−	...	...	Death
144	3-I-14	G.-p. 298	G.-p. 275	9	V.b. 0·2	P.	38·7	8	...	8	...	−	+	−	...	...	+	+	−	+	−	−	+	?	?	Death
147	3-I-14	G.-p. 301	G.-p. 278	7	L.j. 0·1	P.	38·5	2	...	19	...	+	+	−	...	...	...	...	...	...	...	+	+	...	...	Death
155	7-I-14	G.-p. 302	G.-p. 275	13	L.j. 0·1	P.	38·7	7	...	11	...	−	+	−	...	...	−	−	...	...	...	−	?	...	...	Death
156	10-I-14	G.-p. 308	G.-p. 296	7	H.b. 0·4	C.	38·7	3	8	...	...	−	−	−	...	...	...	...	−	...	...	+	−	...	...	Death

V.b.—Venous blood, if from human, drawn from arm vein; if from monkey, from femoral vein; if from guinea-pig, from cavernous sinus. H.b.—Heart-blood. S.—Filtered serum. L.j.—Lung-juice. L.e.—Lung emulsion. P.—Intraperitoneal. C.—Subcutaneous. S.C.—Sinus cavernosus. P.-m.—Post-mortem examination.

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157	10-I-14	G.-p. 307	G.-p. 302	7	V.b. 0·2	P.	38·9	5	...	6	...	+	+	+	...	...	−	...	...	...	...	+	+	...	...	Death
158	10-I-14	G.-p. 309	G.-p. 301	7	V.b. 0·2	P.	38·0	H.b. at p.-m.	3	...	...	+	+	+	...	...	+	...	...	...	...	+	+	...	+	Death
159	11-I-14	G.-p. 314	G.-p. 298	8	H.b. 0·5	P.	37·9	2	2	...	...	−	+	+	...	...	−	...	...	...	...	+	+	...	+	Death
160	12-I-14	G.-p. 312	G.-p. 237 (mosquito-infected)	?	V.b. 0·2	P.	38·3	—	10	...	...	−	−	−	...	...	−	...	...	...	...	+	+	...	...	Death
166	12-I-14	G.-p. 315	G.-p. 297	9	V.b. 0·2	P.	39·2	5	...	23	...	−	−	−	...	...	−	...	−	...	...	+	−	...	...	Death
169	13-I-14	G.-p. 318	G.-p. 314	2	H.b. 0·2	P.	38·6	3	...	10	...	+	−	−	...	...	+	+	...	...	...	+	+	...	...	Death
180	16-I-14	G.-p. 327	G.-p. 307	6	H.b. 0·05	P.	38·8	3	5	...	...	−	−	−	...	...	...	...	...	...	...	+	+	...	...	Death
181	16-I-14	Monkey 326	G.-p. 307	6	H.b. 0·3	P.	40·0	13 (in lung touch) 19	...	20	...	−	−	−	...	...	−	−	−	...	...	−	+	...	...	Death
182	18-I-14	G.-p. 320	G.-p. 302	11	L.j. 0·05	C.	39·0	5	...	9	...	−	+	−	...	...	+	...	...	...	...	+	+	...	...	Death
183	18-I-14	G.-p. 323	G.-p. 302	11	H.b. 0·2	C.	38·7	5	...	9	...	+	−	−	...	...	...	−	...	...	...	−	+	...	...	Death
185	19-I-14	G.-p. 325	G.-p. 263	30	V.b. 0·2	C.	39·2	4	...	16	...	−	+	−	...	...	−	...	...	...	...	+	?	...	...	Death
186	19-I-14	G.-p. 329	G.-p. 263	30	V.b. 0·2	C.	38·4	...	2	...	...	+	+	−	...	...	−	−	...	...	...	−	+	...	...	Death

V.b.—Venous blood, if from human, drawn from arm vein; if from monkey, from femoral vein; if from guinea-pig, from cavernous sinus. H.b.—Heart-blood. S.—Filtered serum. L.j.—Lung-juice. L.e.—Lung emulsion. P.—Intraperitoneal. C.—Subcutaneous. S.C.—Sinus cavernosus. P.-m.—Post-mortem examination.

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187	20-I-14	G.-p. 322	G.-p. 315	8	V.b. 0·2	P.	38·6	H.b. at p.-m.	1	...	...	+	+	+	...	...	+	–	–	...	...	–	–	...	...	Death
188	21-I-14	G.-p. 330	G.-p. 322	1	H.b. 0·05	P.	37·9	H.b. at p.-m.	3	...	...	+	–	–	...	...	–	...	...	...	...	+	+	...	...	Death
189	21-I-14	G.-p. 331	G.-p. 315	9	V.b. 0·2	P.	38·7	3	5	...	...	...	+	?	...	...	+?	+	...	...	...	–	+	...	...	Death
190	21-I-14	G.-p. 332	G.-p. 315	9	V.b. 0·2	P.	38·3	3	3	...	...	+	+	–	...	...	–	–	...	...	...	–	+	...	...	Death
192	21-I-14	G.-p. 334	G.-p. 327	5	H.b. 0·2	P.	38·7	3	4	...	...	–	–	–	...	...	+	...	...	...	...	+	+	...	...	Death
194	24-I-14	G.-p. 335	G.-p. 332	3	H.b. 0·2	P.	39·0	3	11	...	...	+	+	+	...	...	+	–	–	...	...	+	–	...	...	Death
197	26-I-14	G.-p. 340	Monkey 326	10	V.b. 0·2	P.	39·7	2	...	7	...	+	+	–	...	...	+	–	–	...	...	–	+	...	...	Death
198	27-I-14	G.-p. 341	G.-p. 323	9	L.e. 0·2	P.	38·8	5	...	8	...	+	+	+	...	...	–	–	–	...	...	+	+	...	...	Death
199	27-I-14	G.-p. 342	G.-p. 323	9	L.e. 0·5	P.	38·8	4	...	12	...	–	–	–	...	...	–	–	–	...	...	–	+	...	...	Death
201	28-I-14	G.-p. 343	G.-p. 325	9	V.b. 0·2	C.	39·0	...	...	9	...	+	–	–	...	...	–	–	–	...	...	+	–	...	...	Death
202	28-I-14	G.-p. 344	G.-p. 325	9	V.b. 0·2	C.	38·7	—	2	...	...	+	–	–	...	...	+	–	...	...	...	–	?+	...	...	Death
203	28-I-14	G.-p. 346	G.-p. 335	4	V.b. 0·2	P.	38·7	3	...	11	...	–	–	–	...	...	...	–	–	...	...	+	+	...	...	Death
204	28-I-14	Monkey 328	G.-p. 335	4	V.b. 0·2	P.	39·0	6	...	7	...	–	–	–	...	...	–	–	–	...	...	?	–	...	...	Death

V.b.—Venous blood, if from human, drawn from arm vein; if from monkey, from femoral vein; if from guinea-pig, from cavernous sinus. H.b.—Heart-blood. S.—Filtered serum. L.j.—Lung-juice. L.e.—Lung emulsion. P.—Intraperitoneal. C.—Subcutaneous. S.C.—Sinus cavernosus. P.-m.—Post-mortem examination.

We shall now describe in detail our methods and technique, as well as the results obtained.

Methods and Technique

The guinea-pigs were all obtained in Southern Nigeria, to begin with in the neighbourhood of Yaba, but later on, as the local supply became exhausted, from Aro and Ibadan in the interior. They were, during the early period of work, after arrival placed in an open compartment, but latterly were kept in a specially built house protected against mosquitoes by wire gauze. According to requirements, certain numbers, six or twelve at a time, were taken out, isolated in mosquito-proof cages, and their blood examined. When the examination of the blood had shown the absence of *P. flavigenum* in one smear, they were returned to their cages until inoculation. They remained in these cages during the whole course of the disease. The temperature was taken before inoculation, and subsequently twice a day until it was considered of no further interest, but not for a shorter period than ten days except when the animal had died at an earlier stage. The temperatures were taken per rectum at about 8 a.m. and 5 p.m. The blood was in the earlier cases examined daily, and later on as often as possible, selecting the days on which parasites would be most likely to be detected, according to the experience already gained.

When a guinea-pig died, a post-mortem examination was performed as soon as possible after death. The urine was examined for albumen, and the gastric mucosa for any abnormal conditions. Touch-preparations were taken from the lung, spleen and liver, and usually also from the bone-marrow. Specimens of lung, spleen, liver and kidney were preserved in sublimate alcohol (two parts of saturated watery solution of mercury bi-chloride and one part of absolute alcohol), and additional specimens of liver and kidney, and in some cases of pancreas as well, were preserved in 10 per cent. formalin.

The term 'touch-preparation' may require a few words of explanation. We found 'smears' from the organs of very little use, but obtained excellent results in the following way. A small fragment of the organ is held with a forceps, with the cut surface upwards. If a considerable amount of blood is exuding it is

scraped off with the edge of a slide. The cut surface is then gently touched with the downward-looking surface of a slide, this being repeated a number of times until the larger part of the slide is covered with a number of separate or slightly confluent films. The specimens are dried as quickly as possible in the air, by moving them to and fro, and subsequently treated in the same way as blood films.

Guinea-pigs which died during the same period without having been inoculated were similarly examined.

Blood smears and touch preparations from organs were fixed in methyl-alcohol and stained intensely with Giemsa's solution or with Pappenheim's panchrom. The sublimate-alcohol specimens were embedded in paraffin and stained with Giemsa's solution or with Pappenheim's panchrom, and other sections with iron-haematein or haemalum, either without counter-staining, or counter-staining with Hansen's aceto-picro-acid fuchsin (aceto-picro-rubin) solution or with eosin.

The formalin specimens were cut with the freezing microtome (carbonic acid) and stained with Sudan III and Mayer's haemalum. Some paraffin sections were also made of the formalin tissues and stained with iron-haematein and eosin.

The blood smears and organ-touches were examined by one or other of us, and elements of particular interest were nearly always seen by both observers.

The microscopes used were Zeiss's large model, and we generally worked with either apochromatic objective 3 mm. and compensating eye-piece No. 12, or with apochromatic objective 2 mm. and compensating ocular No. 8, i.e., in either case with a magnification of about 1,000 linear, more powerful systems being used only when required. The great advantage of apochromatic lenses does not consist so much in the higher degree of magnification obtainable, as in the sharper definition.

The histological examination of the tissues obtained post-mortem could not be completed in the time at our disposal in Yaba, and they will be reported later by one of us in a separate paper.*

These general lines of observation and examination were

* *Vide* pp. 501-526 *infra*.

followed in all cases, but not so with the methods of inoculation, which need a few words of discussion. In the experiments previously performed by one of us (Seidelin, 1912) it was considered advisable to transfer the parasites directly from the blood-current of the infected animal to that of the fresh one. For this reason blood was taken from the living animal by puncture of the heart and immediately afterwards injected without any admixture into the heart of the fresh guinea-pig by puncture through the thoracic wall. It soon became evident that this method would not be practicable in our present work. There is no great difficulty in puncturing the heart, but especially strong needles are necessary, as they sometimes encounter the ribs, and the lumen must be wide as the blood is apt to coagulate before re-injection can take place. We had, however, learnt by private information from Dr. Macfie (see Macfie and Johnston, 1914) that good results had been obtained by the subcutaneous injection of blood with the admixture of sodium citrate solution. We had also become acquainted with the paper by Pettit (1913), who recommends puncture of the sinus cavernosus through the orbit in small laboratory animals, in order to withdraw blood directly from the circulation, as well as for inoculation into the blood current. As a routine procedure we therefore adopted the withdrawal of blood from the cavernous sinus, mixing it in the syringe with an equal quantity of 1 per cent. sodium citrate solution. In a few cases we also injected the blood directly into the cavernous sinus, but as several animals died immediately after such an operation, we finally adopted subcutaneous, or, in the majority of cases, intraperitoneal inoculation. No essential difference was apparent between the results obtained by one or the other of these methods, but the intraperitoneal injection has the advantage that it is just as easy to introduce a comparatively large, as a small, quantity of blood. The amount of blood injected varied from 0·05 c.c. to 1 c.c. of pure blood, and we could find no definite correspondence between the intensity of the infection produced and the quantity of blood introduced. Marked reactions occurred after subcutaneous as well as after intraperitoneal injection, and with a dosage of 0·1 c.c. as well as of 1 c.c. of pure blood.

With regard to the stage of the infection in the guinea-pig from

which the blood to be injected was taken, an analysis of Table III shows that there is no definite relationship between this stage and the severity of the infection produced. Death occurred in two animals two days after inoculation, and in both cases the blood had been drawn from a guinea-pig which had been inoculated 8 days previously. On the other hand, death after 3 days was observed in two cases in which the blood injected had been taken at a very early period of the disease, namely, 3 days after inoculation. Death after 4 days occurred in two guinea-pigs inoculated with blood drawn 5 and 7 days after inoculation, respectively. Death after 5 days was observed in two animals injected, the one with blood taken 4 days, and the other with blood drawn 7 days after inoculation. Other examples could be quoted, but it must be stated that for periods of more than 5 days our figures are not reliable, as many animals were killed after different periods, and these, of course, have to be excluded from the comparison. It should, however, be noted that one guinea-pig survived 55 days, which had been injected with blood taken two days after inoculation. There were also survivals of 33 days and 34 days in two animals infected with blood taken 4 days after inoculation.

We have not found any relationship between the height of the temperature of the animal at the time the blood was withdrawn, and the severity of the infection produced in the sub-inoculated guinea-pig. In all the cases referred to in the preceding paragraph the temperature was at about 38·3° C. (101° F.), at the time of the withdrawal of the blood.

Without any further discussion we can also state that we have failed to find any correspondence between the absolute height of the temperature observed, and the result, fatal or otherwise, in the animals from which inoculations were made, and the severity of the infection produced.

Thus it would appear that the severity of an infection depends more upon other factors than upon the intensity of the infection in the animal from which the inoculations are made. These factors might be concerned with the phase of the parasite, a point which will be discussed later. It may here be stated, however, that this does not appear probable, considering the varied conditions with regard to stage and intensity of infection, as mentioned above. It

would appear much more likely that the result depends chiefly on differences in individual resistance in the animals inoculated, which would correspond to the experience obtained in experimental inoculations of yellow fever in the human, as well as to that obtained in other infectious diseases. We have no material which would enable us to make any definite statement on this point, as no observations were made with regard to age, weight, etc., of the guinea-pigs used for inoculation. Neither can we at present make any definite statement with regard to the possible rôle which previously acquired immunity may play in this connection. The latter question was investigated by means of reinoculations, but these experiments were few, and the results not conclusive.

Other Methods of Infection

We found but little reason to vary our methods of infection, having obtained uniformly good results by means of subcutaneous and intraperitoneal injections of blood. Thus the use of other techniques would recommend itself more as a means of obtaining additional information than in the hope of improving our results.

I. It would be important to inject various secretory and excretory fluids, and above all, emulsions of various organs, as it might be possible in this way to throw light on the distribution of the parasite in the various internal organs, a problem, for obvious reasons, very difficult to solve by microscopical methods. The time at our disposal was quite insufficient to enable us to start this work on a reasonably large scale with any chance of success; we therefore limited ourselves to making a few injections of juice obtained by puncture of the lungs at post-mortem examinations, or of emulsions made by triturating fragments of lung in 0·85 per cent. saline solution (likewise post-mortem material), as the presence of numerous 'blue bodies' in these organs was the most striking observation which we made in the course of our study.

The following temperature charts show the results obtained in one case with puncture fluid from the lung, and in another case with an emulsion of lung tissue:—

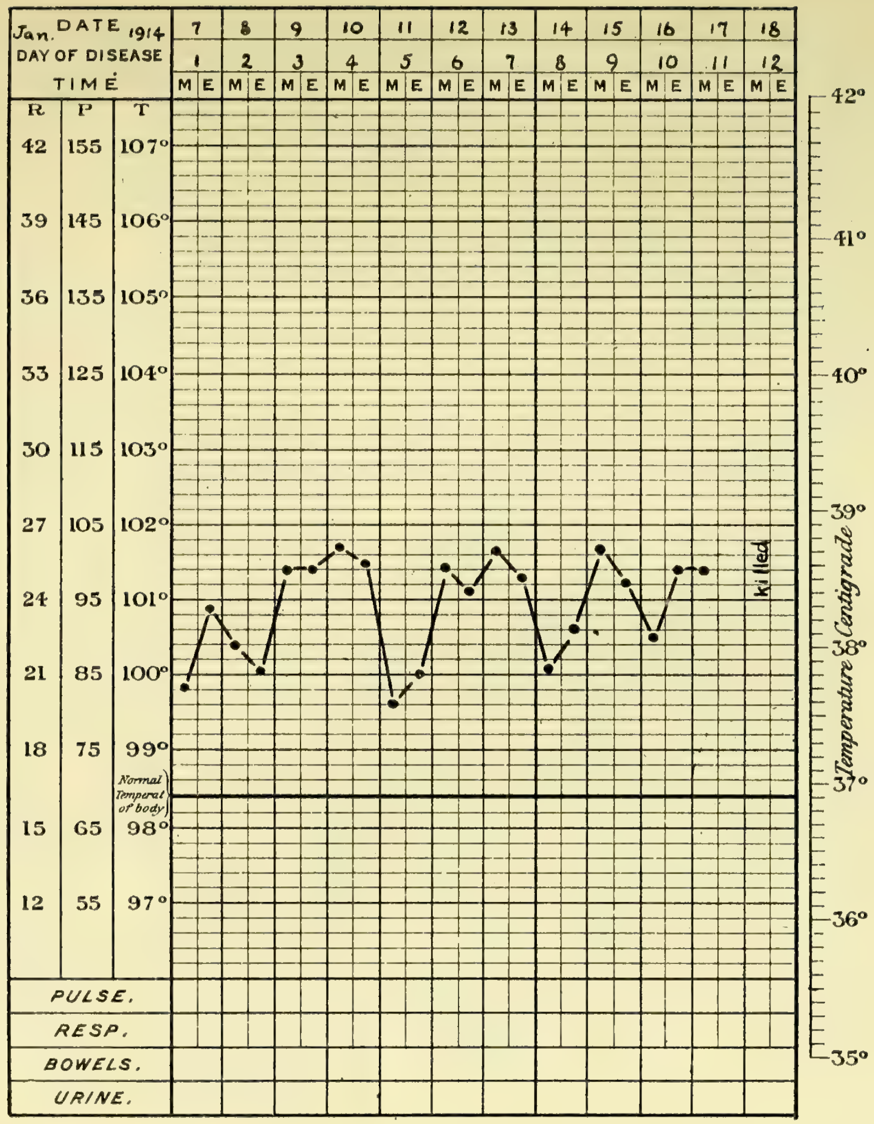

Chart 13—G.-p. 302

Injection with lung-juice.
Before inoculation: No parasites.
Parasites found: January 14.
Post-mortem examination: Petechiae in stomach. No albumen in urine. No parasites in lung. ? Blue bodies in spleen.

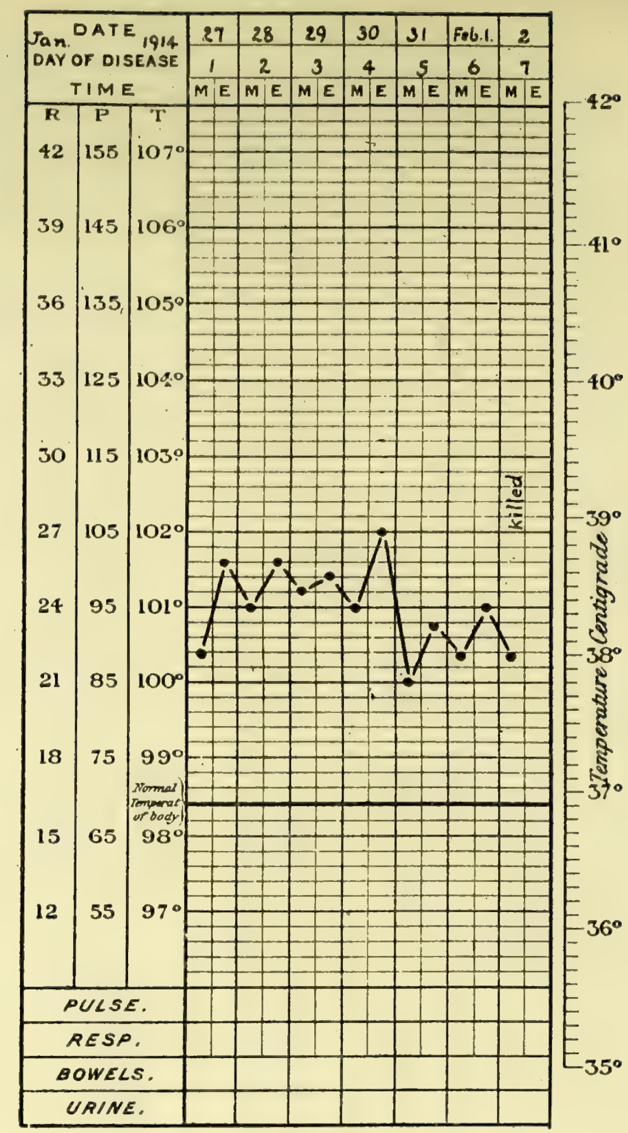

Chart 14—G.-p. 341

Injection with emulsion of lung-tissue.
Before inoculation: No parasites.
Parasites found: February 1.
Post-mortem examination: Gastric hyperaemia petechiae, and erosions. No albumen in urine. Blue bodies in lung and spleen.

II. *Experiments with filtered serum.* It is well known that various observers have obtained positive results by the injection of filtered yellow fever serum, when experimenting on human beings. We performed two experiments of this kind on guinea-pigs, passing the serum diluted in the proportion of 1 in 10 with 0·85 per cent. saline solution through a Doulton's filter which had been proved to retain *M. melitensis.* The temperature reaction was but little marked, and parasites were only found in the peripheral circulation of the inoculated animal at a late stage of the infection. The latter circumstance, however, is of little importance, as the blood was not frequently examined.

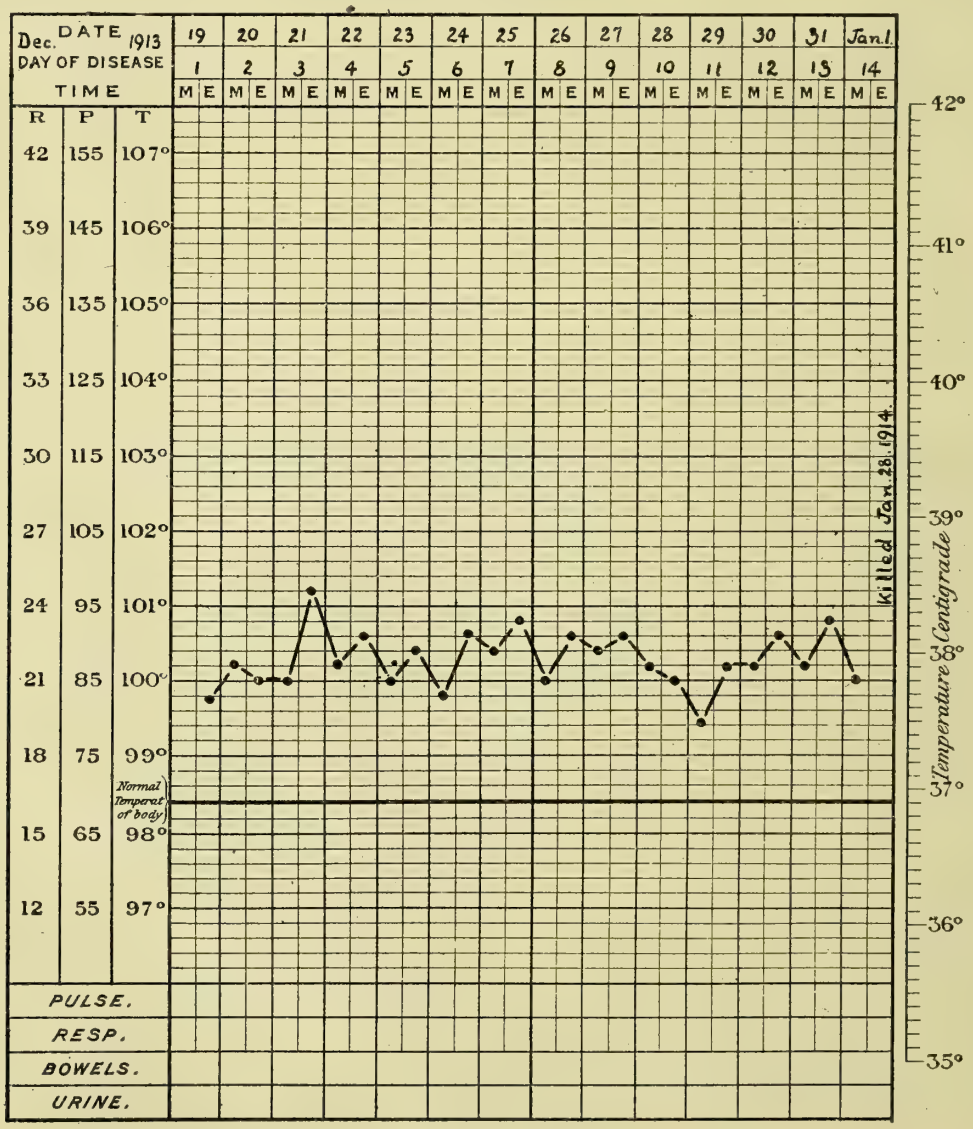

Chart 15—G.-p. 260

Before inoculation: No parasites.
Parasites found: January 23
Post-mortem examination.—Albumen in urine, no other pathological phenomena. Blue bodies in spleen, none in lung.

III. *Mosquito-transmitted infections.* We made a considerable number of mosquitoes feed on infected guinea-pigs. The majority of these insects were used for microscopical examination, and only in a few cases was the attempt made to transmit the infection to other guinea-pigs. The results in these cases were somewhat surprising, as infection was produced by means of mosquitoes which had had their infecting feed only a few days previously. These experiments are of particular interest in view of the results of transmission experiments obtained by Finlay (1886) about thirty years ago. Table IV shows the results obtained, and the following is the chart of a case :—

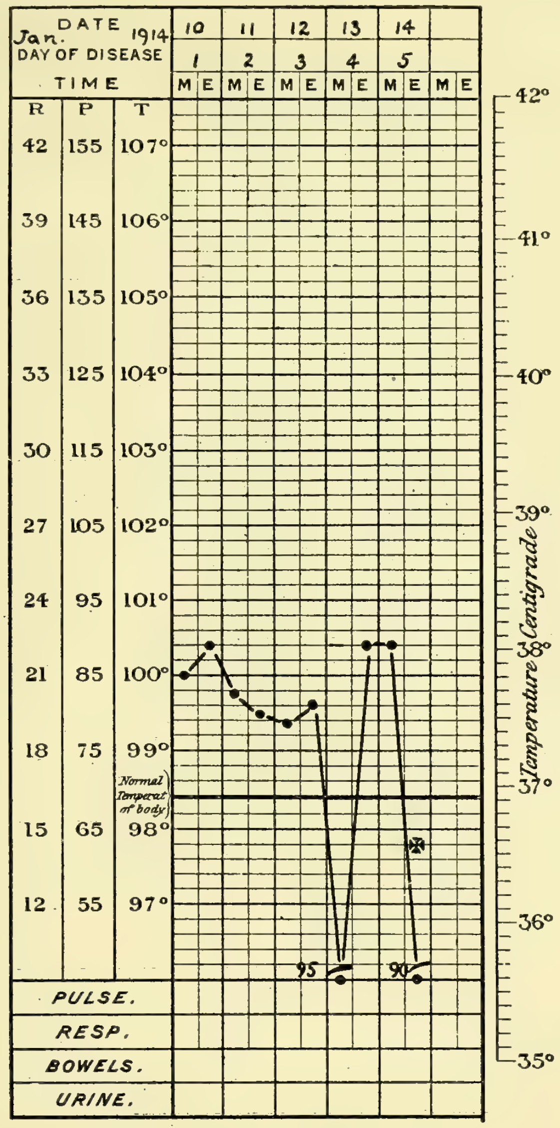

Chart 16.—G.-p. 306

Mosquito transmission.
Before inoculation: No parasites.
Parasites not found before death (blood not examined before inoculation).
Post-mortem examination.—Gastric petechiae. Albumen in urine (faint reaction). *P. flavigenum* in heart-blood and lung, blue bodies in spleen.

Table IV

Mosquito-Transmission

Exp. No.	Date	Animal No.	Infected from	Infecting animal bitten — days after infection	Days between infecting bites	Highest temperature	Parasites first found — days after infection	Death — days after infection	Killed — days after infection	Stomach			Fat		Urine Albumen	*P. flavigenum*				Blue Bodies			
										Hyper-aemia	Haemorr-hages	Erosions	Liver	Kidney		Lung	Spleen	Bone-marrow	Liver	Lung	Spleen	Bone-marrow	Liver
62	26-XI-13	G.-p. 211	G.-p. 182	9-11	5-12	39·1	34	40	...	–	–	–	...	...	–	...	...	...	...	+	+	...	...
75	8-XII-13	G.-p. 237	G.-p. 223	7	3	38·6	14	...	45	–	–	–	...	...	–	...	...	...	...	–	–	...	...
146	4-I-14	G.-p. 313	G.-p. 268	7	7-10	...	–	3	...	–	–	–	...	...	–	–	–	...	...	–	–	...	...
148	9-I-14	G.-p. 311	G.-p. 275	12	3	38·7	9	...	17	–	–	–	...	...	–	...	...	...	...	+	+	...	...
149	9-I-14	G.-p. 306	G.-p. 143	83 (7)	3	38·0	H.b. at p.-m.	...	...	+	+	–	...	...	+	+	...	...	...	...	+	...	...

H.b.—Heart-blood. p.-m.—post-mortem.

Incubation

No definite incubation period was apparent. In some cases the temperature rose on the day of inoculation, in others the rise did not set in until two, three or four days after.

Symptoms

The one symptom of which it is possible in a series of animal experiments to keep a careful record, is the pyrexia. The record of the course of the temperature in our cases could not be made as carefully as desirable, for practical reasons. It is quite possible that two-hourly or four-hourly charts would have revealed further details of interest, but as it is, it seems to us that valuable information can be obtained from a study of the curves of the temperature taken twice a day. With regard to the normal temperature of guinea-pigs observed under the conditions existing at the place and time of our work we would say that it shows a considerable range of variation. Our impression is that any temperature between 37·2° and 38·4° C. (99° and 101° F.), may, generally speaking, be considered within the limits of the normal. This, of course, does not exclude the fact that, in individual cases, isolated rises of temperature to or just above 38·4° C. (101° F.) may be pathological, especially if they occur shortly after injection or just before death. The temperature, in marked reactions, may rise to or above 39·4° C. (103° F.), as shown in the charts already given, and not infrequently an initial rise was followed by a remission and a secondary elevation of temperature. The charts, in such cases, show a marked resemblance to those observed in cases of yellow fever in the human, but this condition cannot be laid down as a rule.

We have no observations on the pulse-rates in the infected guinea-pigs.

Just before death there was often a marked collapse, during which subnormal temperatures were observed; in one case the reading was 32·8° C. (91° F.), whilst temperatures of 34·6° C. and 35° C. (94° F. and 95° F.) were of frequent occurrence. Apparent recovery, spontaneous or after caffeine injection, took place in a few

cases after such collapse. This reaction was, however, in some cases of short duration, death supervening on the following day; in other cases the reaction was followed by complete recovery, as far as the observations were continued.

The following charts illustrate these conditions:—

Chart 4—G.-p. 258 (see p. 430)

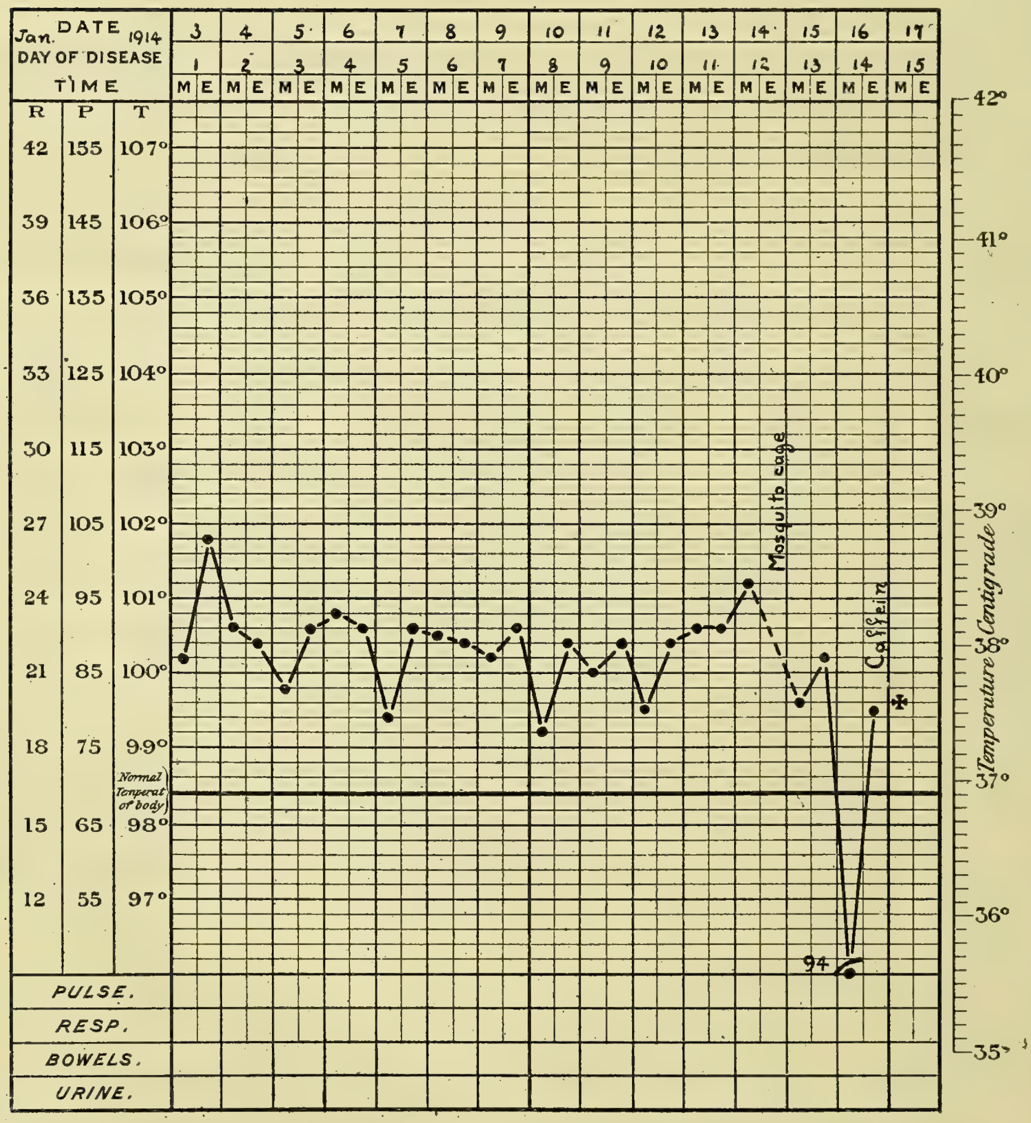

Chart 17—G.-p. 297

Before inoculation : No parasites.
Parasites found : January 13.
Post-mortem examination : Large ecchymoses in stomach. Albumen in urine. Blue bodies in lung. No parasites in spleen.

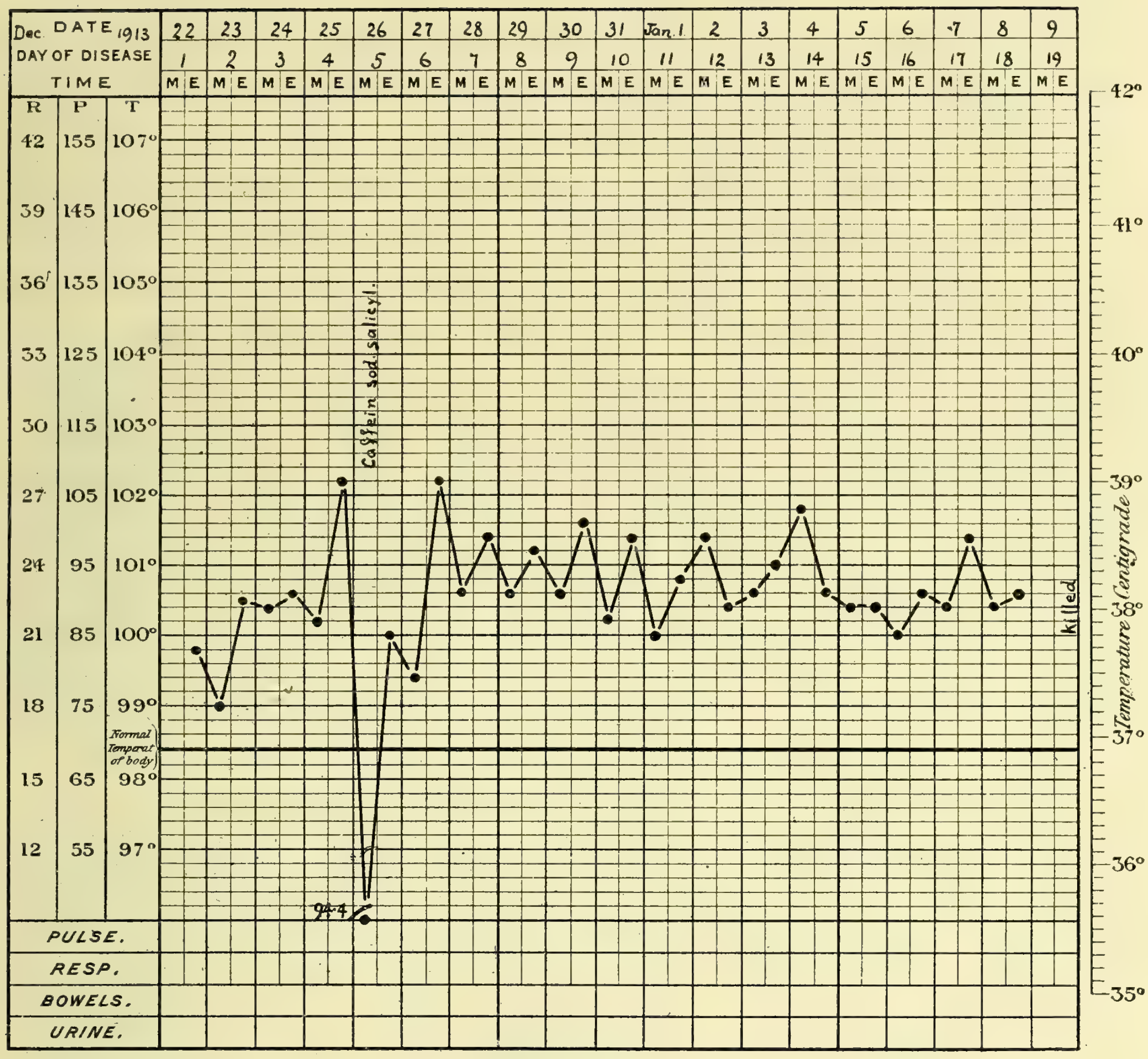

Chart 18—G.-p. 268

Before inoculation : No parasites.
Parasites found : December 24, 25, 26, 27, 28, 29.
Post-mortem examination : Gastric hyperaemia. No albumen in urine. Blue bodies in lung, spleen, and liver ; none in bone-marrow.

Albuminuria was only observed at the post-mortem examination, as we did not find it practicable to collect the urine from the living guinea-pigs. It appears, however, material to discuss these observations among the clinical symptoms, to which they essentially belong. Omitting the cases in which no urine could be obtained for examination, we find that albumen was present in 25 out of 36 cases in which death had occurred spontaneously, and in 9 cases out of 30 in which the animals had been killed. The intensity of

the reaction varied from a faint trace, only occasionally observed by Tanret's test, to a dense disc 1 mm. thick, by Heller's reagent.

It is difficult to make any definite statement with regard to the true mortality due to the infection, as a certain number of non-inoculated guinea-pigs died spontaneously at the same time. If, however, we count only up to fifteen days after inoculation, excluding the guinea-pigs killed before this period had elapsed, and counting as deaths due to the infection only those cases in which corresponding anatomical lesions were found at the post-mortem, we find that death occurred in 22 cases out of a total of 80 available at the time of writing this report, i.e., a mortality of 27·5 per cent.

In addition to these cases of death in the acute stage, we observed several cases in which death occurred from some weeks to two months after inoculation. The post-mortem examination showed an entire absence of lesions corresponding to an acute infection, a more or less marked albuminuria being the only phenomenon noted.

Anatomical Lesions

The corresponding histological examinations had not been completed at the time of writing this paper. We can, therefore, at the present time only discuss the macroscopical post-mortem appearances. The most striking lesion observed was undoubtedly a marked affection of the mucous membrane of the stomach, which was present in the vast majority of the cases. This affection varied from a more or less marked hyperaemia to an intense acute gastritis with swelling and hyperaemia, haemorrhages, occasionally in patches, and haemorrhagic erosions. Between these two extremes all transitional stages were observed. The haemorrhages varied in size from minute petechiae to confluent ecchymoses of quite considerable dimensions. The erosions were in some cases so minute that it was necessary to use a hand-lens to make certain of their nature; in other cases they exceeded the size of a linseed. No definite localisation of the haemorrhages and erosions seemed typical; they were observed in all parts of the stomach, though perhaps the cardiac end was somewhat more frequently and more intensely affected than the pyloric and intermediate parts.

Other organs appeared but slightly affected. Some cases showed a marked hyperaemia of the lungs, but this was by no

means a constant nor even a common phenomenon. Other cases presented moderate hyperaemia of the liver and kidneys, but just as often these organs appeared perfectly normal. The liver appeared distinctly fatty on macroscopical examination, in some few cases. In no instance was any abnormal condition of the spleen recognised macroscopically.

Treatment

In an early period of our experiments we were under the impression that by means of repeated passages through animals of the same species we should succeed in obtaining a yellow fever virus showing a fixed virulence for guinea-pigs. We had proposed then to try the effect of salvarsan, K_3 (which Geheimrat Ehrlich had kindly put at our disposal), trypan blue, and perhaps of other substances which had been found useful in the treatment of protozoal diseases. Failing, however, to fix the virulence, it appeared a hopeless task to attempt therapeutical experiments, as we could never feel certain whether the animals would have succumbed to the infection, or not. Under such conditions, a much larger series of experiments would have had to be carried out than we could have undertaken at the time. We therefore abstained from all treatment, excepting that we used caffeine-injections in several cases of collapse, as a rule without results, but in a few instances (guinea-pigs 268, 297) followed by temporary or final recovery. It should be mentioned, however, that in at least one animal, spontaneous recovery was observed after a severe collapse (guinea-pig 306).

Experiments on Monkeys

We found no reason to carry on any experiments on a large scale on animals other than guinea-pigs, in which we had obtained such good results. Our chief object was to study the yellow fever parasite, and for this we had ample opportunity in the guinea-pigs.

For some time we believed that we should be able to increase and fix the virulence of our strain of the parasite for guinea-pigs. When we failed to do so, we resolved to perform some experiments on higher animals, and so, a few weeks before the conclusion of

our investigations, we obtained a few monkeys. These, however, could not be considered quite favourable objects for experimentation, as they all (three in number) harboured other parasites in their blood, namely, parasites of the genus *Plasmodium*. One of the monkeys, a young *Cercopithecus mona*, was inoculated shortly after its arrival, so that there had been no time for observing its temperature before inoculation. Thus, we cannot definitely assert that the very marked reaction observed after the injection of *Paraplasma*-containing blood was entirely independent of the presence of the 'malaria' parasites, but there is a very great probability that it was actually due to the yellow fever organism, as the curve of the temperature corresponded much more to what one would expect in yellow fever than to the course of the pyrexia observed in malaria, and also because the *Plasmodium* was always present in its blood in very small numbers, with the significant circumstance that all the forms seen were gametocytes.

This monkey apparently recovered from the infection, and it was not considered advisable to kill it too soon as we had no other monkey of the same kind at our disposal. It was therefore operated upon twice, once in order to obtain material from a lung, and on the second occasion in order to observe the condition of the stomach and to excise a portion of the spleen.

The following are the notes and temperature chart from this case:—

Monkey 326. *Cercopithecus mona*. January 16th, 1914. At 4 p.m. intraperitoneal injections of 0·3 c.c. of heart blood from guinea-pig 307, which had just been killed (the blood was mixed with an equal volume of 1 per cent. sodium citrate solution).

January 22nd.—Puncture of right lung was performed, and smears were made with the fluid obtained.

January 29th.—The animal was anaesthetised with chloroform followed by ether, and a pneumectomia partialis performed. Subperiosteal resection of about 1 cm. of the eighth rib in the posterior axillary line was followed by resection of two small fragments of the inferior lobe of the lung. Touch-preparations were made, and the fragments immediately afterwards fixed in sublimate-alcohol. The lung and the thorax-wall were sutured. The animal reacted well after the anaesthesia.

January 31st.—Chloroform-ether anaesthesia. An abdominal section was made in the median line and a small fragment of the spleen resected, which was used for touch-preparations and afterwards fixed in sublimate-alcohol. The stomach was opened and the whole of the mucosa inspected; no ecchymoses were observed, nor any other lesions. The wounds were closed. The animal

collapsed towards the end of the operation, but reacted on strychnine injection.

February 4th.—The animal was killed. Wounds clean; no infections of pleura or peritoneum; no albumen in urine, and no lesion of the stomach except the incision which was healing well.

Paraplasma flavigenum was found in the blood of this monkey, and 'blue bodies' in touch-preparations from the lungs.

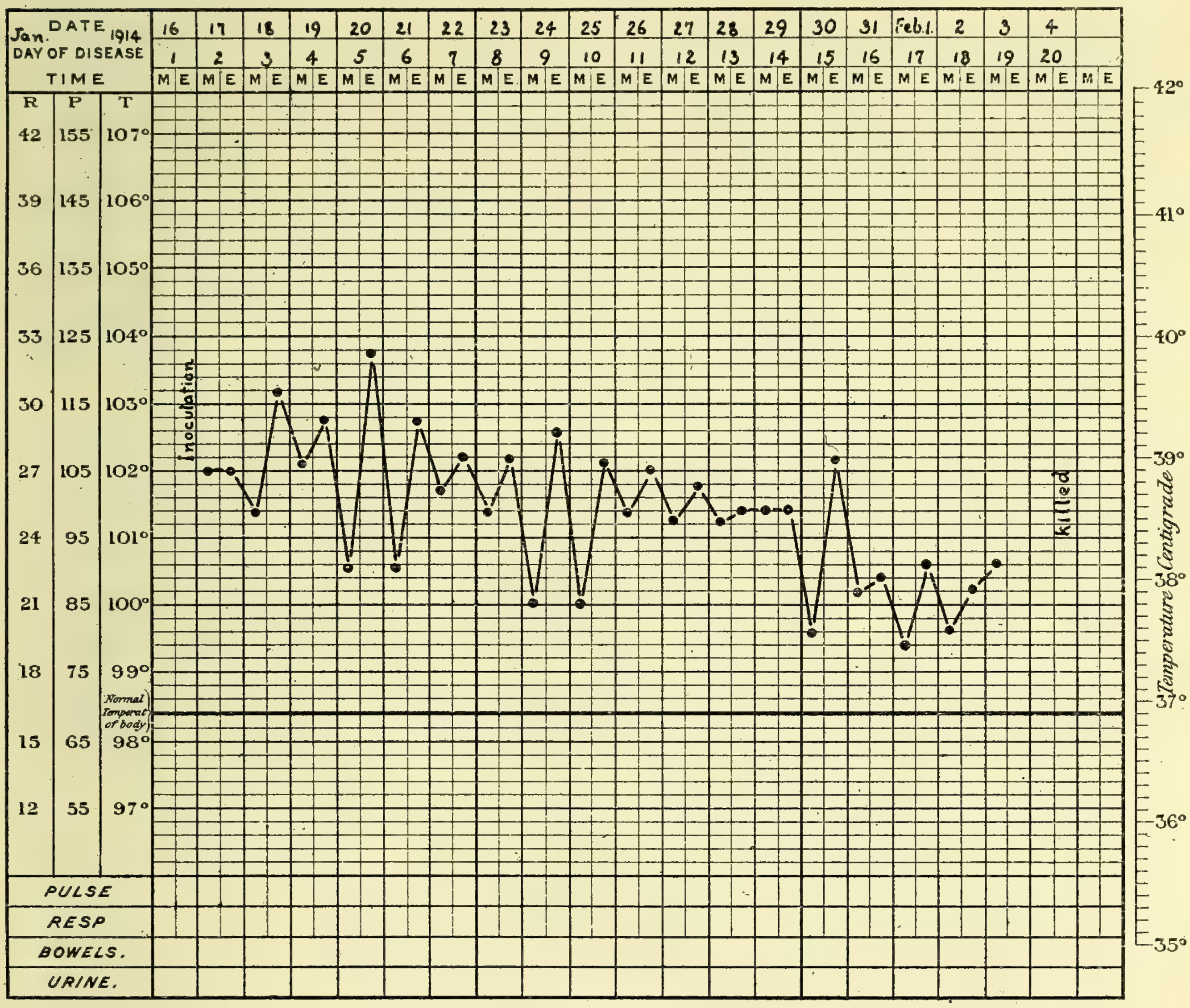

Chart 19—Monkey 326

Before inoculation: *Plasmodium sp.* present in the blood, but no parasites resembling *P. flavigenum.*
Parasites found: January 29, in piece of lung removed by operation.
Blue bodies found: January 31, in piece of spleen removed by operation.
Post-mortem examination: No pathological phenomena. Blue bodies in spleen.

The other two monkeys inoculated were both *Papio sphinx*. In both cases parasites were found in the blood smears, but no marked

febrile reactions were observed, and albuminuria and gastric lesions were absent in the first case; the second animal had not been sacrificed at the time of writing this report.

Paraplasma flavigenum *in the Blood of Infected Animals*

We have inserted figures in Table III, showing in each case how many days elapsed after inoculation before *P. flavigenum* was found in the peripheral blood. These figures give only an approximate idea of the time when the parasites really appeared, as the blood was examined daily in the first twenty cases only; in the later cases examinations were only made at intervals of several days. Further, during the last month or two, blood smears were taken once only in the first instance, two or three days after inoculation, and the examination was not repeated when the result was positive, but in the case of a negative result smears were examined repeatedly.

From this discussion must be eliminated 7 cases in which the blood was not examined before death. In 96 cases examination of the specimens showed the presence of *P. flavigenum*, whilst 9 cases were negative. In 3 of these, parasites were found in material obtained after death, whilst in 6 cases the results of examination were negative. As in the same cases anatomical lesions were entirely absent, it may be concluded that the inoculation produced no infection in these animals. Thus we had positive results in 99 out of a total of 105 cases examined; about 94·3 per cent.

With regard to the first appearance of the parasite in the peripheral circulation, it seems advisable to consider only the small group of twenty cases in which daily examinations of the blood were carried out. One of these cases must be eliminated for reasons presently to be stated. In nineteen cases, then, we found that parasites were present in the peripheral blood; in seven cases after one day, in six after two days, in two after three days, in two after four days, and in one case after six days. In the remaining case, the results were negative during the first eight days of observation, and the blood examination was discontinued thereafter. The case referred to as necessitating elimination is guinea-pig 140: it was injected on 13th October, 1913, and parasites were found in the blood taken before inoculation. It

was, however, found afterwards that this animal had been used for another experiment several days previously, in which an intra-cardial injection of heart blood from an infected guinea-pig had been attempted. This experiment was not considered of any value at the time, as the blood had coagulated in the syringe, but there seems to be no doubt that one or a few drops of blood had actually been injected. Before the first injection, the blood-examinations had been negative.

In the vast majority of smears, the parasite was as scarce as we have usually found it to be in human blood, namely from two or three to about a dozen in a thin film. We found however, in a few cases (as one of us—Seidelin, 1912—has also found in human blood), the parasites in large numbers, comparatively speaking, namely, over fifty in a smear, and sometimes as many as three or four parasites have been seen in one microscopical field.

The morphological characters of the parasites were very much the same as those in human blood. We observed extremely minute chromatin dots with the faintest possible trace of blue-stained protoplasm, as well as delicate rings, and more massive solid bodies with one or several chromatin granules, and also free elements showing well-stained protoplasm and chromatin. In brief, we found all the forms described and figured by Seidelin in his various papers. We found in the peripheral blood no division forms with complete separation of the merozoites (see Seidelin, 1912, Pl. I, fig. 21), but forms with fairly regularly situated chromatin granules resembling schizonts in an advanced stage of division. For the sake of comparison with material from human cases we give, on the accompanying plate, a series of figures from the blood of the patient, from whom the blood for the first inoculation was taken, together with other figures, showing the various forms observed in guinea-pigs.

Paraplasma flavigenum *in material recovered at post-mortem examinations*

We collected material at the post-mortem examinations in all, except a very few, cases of death. The few exceptions were cases in which the animal had obviously been dead for some time, so that we deemed it inadvisable to examine the decomposed material.

The urine was collected as far as possible: the findings have been mentioned in a previous section.

As a routine procedure, fragments of lung, liver, spleen and kidney were fixed in Schaudinn's sublimate-alcohol, and small portions of liver and kidney, and in some cases myocardium and pancreas were preserved in formalin. The results of the examination of sections will be reported upon in a later paper.*

At the beginning of the examinations, smears were taken from the heart-blood in all cases, but as no results were obtained in this way which differed essentially from the results of examining the peripheral blood in life, such smears, in later cases, were only taken when the animal had died at such an early date that the peripheral blood had not been examined.

More interesting results were obtained from the examination of slide films (touch-preparations) from the organs.

In these films ordinary forms of the parasites were found, occasionally in somewhat larger numbers than they had been found in the peripheral blood, or in the heart blood, but in no case could they be described as very numerous, and often they were quite scanty. Entire absence of the parasites in their ordinary forms was often observed when death took place a considerable time after the inoculation.

Intracorpuscular division-forms, similar to those described in the peripheral blood, were sometimes met with, but were always rare. No other forms of special interest were noticed, except those which apparently represented the transition to the bodies now to be described. The most striking elements observed in the organ-touches were extracorpuscular bodies, which we will call provisionally and for the purposes of description 'blue bodies,' using the term commonly applied to the elements first described as 'Plasmakugeln' by Koch (1906) and others in East Coast Fever, in cattle. These bodies were in the first instance observed in lung-touches from a guinea-pig which had been killed on the seventh day after inoculation. Afterwards they were seen in numerous cases in touch-preparations from the various organs examined, i.e., lung, spleen, bone-marrow and liver, and though as a rule most numerous either in lung or spleen touches, they were very rarely numerous in both

* *Vide* p. 501 *infra*.

these organs in the same animal. The advanced stages of the evolution of the blue bodies were found chiefly in the lungs. After considerable experience had been gained in the examination of these elements it appeared evident that they developed from intracorpuscular forms, and their probable evolution can be described as follows:—

The first stage seen differs but little from the ordinary intracorpuscular forms of *P. flavigenum*, though perhaps the chromatin is somewhat larger and the protoplasm more compact. These differences become more and more accentuated, and the parasite, whilst still intracorpuscular, grows to a size far in excess of that of the ordinary forms. It now appears that the parasite develops in one or the other of two different ways. In some cases they apparently become extracorpuscular, and the chromatin is still compact, forming one comparatively large mass. In other cases the chromatin becomes arranged along the periphery of the blue body whilst the latter still remains intracorpuscular. In this position the chromatin appears less compact, and stains less deeply than in the ordinary forms. The largest of these intracorpuscular bodies have a diameter of about one-fourth to one-third of that of an erythrocyte. Once having become free, whether at an earlier or a later stage, the parasites further increase in size and the chromatin divides. It appears that the chromatin, if already peripheral, retains this position and breaks up into a considerable number of small elements; how many we cannot state at present. On the other hand, in the forms with compact chromatin at one extremity, the body becomes rounded, and the chromatin becomes more or less central before it proceeds to division. In these cases the division appears to be a simple repeated fission; thus in some forms two nuclei are seen, in others four, and in others, again, finally eight. Immediately after, or even at the time of the last nuclear fission, the protoplasm evidently divides, as no forms have been observed in which eight chromatin particles were present in an undivided protoplasm. Thus, eight elements result from the division, and they seem to belong to two different types. In some of the round bodies elongated elements appear in which no further process of division has been observed. In other cases the resulting elements are more or less polygonal in shape, and in these it appears that

further division takes place, and thus perhaps a similar result is obtained to that observed in the bodies with peripheral chromatin. It is also possible that a similar process occurs in the case of the elongated 'spores,' but transitional stages have not been observed. This possibility, according to which secondary divisions would take place in all cases, suggests itself, because the larger division-elements have never been seen in a free state. If this be so, it is probable that the division goes on until exceedingly minute elements, apparently consisting entirely of chromatin, have been formed. Such minute elements have been seen inside round 'capsules,' and they are the only elements of the series which have also been observed in a free state.

Phagocytotic Phenomena

Without making any definite statements which might perhaps not be borne out by the result of a close histological study, we wish to mention briefly some very marked phenomena of phagocytosis which we observed in numerous touch-preparations from lung, spleen, liver, and bone-marrow.

Three different kinds of elements were observed incorporated in phagocytes, namely, erythrocytes, parasites, and pigment. Apparently only one kind of phagocyte was concerned, namely, the large mononuclear leucocytes.

Erythrophagocytosis was observed in nearly all the smears examined. The intensity of the condition varied greatly, but as a rule it was well marked. We are unable to furnish any information which might shed fresh light on this interesting process, which has recently been discussed in connection with tropical diseases by Connal (1912), and Macfie and Johnston (1913 and 1914). Two, or three, or more ingested corpuscles were commonly observed in one erythrocyte. We could trace no definite connection between the severity of the infection or the duration of the disease and the degree of red-cell ingestion. The phenomenon was observed in mononuclear leucocytes in films from both lungs, liver, and spleen.

The ingested parasites were either small ring-forms or 'blue bodies.' In both cases the parasites were either free in the protoplasm of the monocyte or included in phagocytosed erythrocytes.

Ingestion of small forms was a comparatively rare phenomenon, and was seen with about the same frequency in touches from the various organs, and also occasionally in the peripheral blood; phagocytosis of blue bodies was fairly common in the lung-touches, but only exceptionally seen in specimens from other organs.

Ingested pigment, apparently bile-pigment*, was observed in numerous films from the spleen, and very rarely in other specimens. The phenomenon was also seen in other cases, but from a considerable experience we feel authorised to state that it was much more marked in the infected than in the non-infected guinea-pigs.

In view of the very interesting results obtained in the last few years by culture experiments on malaria parasites and *Babesiae* by Bass, Thomson, Fantham, Ziemann and others, it was obviously reasonable to try similar experiments in the case of the *Paraplasma.*

Seven experiments of this nature were performed (Experiments 2B, 3B, 11, 26, 65, 77, and 121), but we abstain from giving a detailed discussion, as no very demonstrative results were obtained. In several cases there was an undoubted numerical increase of the parasites in films from the culture tubes after one, two or three days, in comparison with the original blood films, but in no case were division forms obtained. We must therefore leave the question open whether the increase was real, depending on a division which was not observed, or whether it was only apparent, in which case it might depend either upon agglomeration of the infected corpuscles in the upper layers of the blood, or upon a growth of previously invisible forms into visible.

We shall not describe the various techniques employed, as we cannot recommend any one in particular; we wish to mention, however, that in one case we added—but without result—a small quantity of bile to the mixture of blood, sodium citrate, and dextrose.

Spontaneous Infection in Guinea-pigs

The question of the natural infection of guinea-pigs by *Paraplasma*-like or other protozoic parasites has received the attention which its great importance requires in our experiments.

We leave out of account the occurrence of Kurloff bodies. They were found in a very large number of the guinea-pigs, and we do

* *Vide* pp. 511 and 512 *infra.*

not consider that any of the stages of development of these bodies have been confused with the elements which we have described in the evolution of *P. flavigenum.*

In the following section we discuss the possibility of confusion with the lung parasites described by Chagas as developmental stages of *Trypanosoma cruzi.*

The possibility has always been prominently before us that spontaneous infection of the guinea-pigs might occur, more especially in a country where Babesiasis exists.

The two safeguards which we adopted with the object of controlling our experiments were the examination of a smear from the peripheral blood of every animal before inoculation, and a complete post-mortem examination of all stock guinea-pigs which died without having been used in the experiments.

The blood from a total of 170 guinea-pigs and 3 monkeys was examined. All the monkeys showed *Plasmodium,* but none of the stages observed of these parasites resembled in any way the forms of *P. flavigenum.* With regard to the guinea-pigs, however, six animals had to be discarded on account of their harbouring in the peripheral blood a minute parasite which resembled *P. flavigenum.* These animals were killed, and post-mortem material was taken for examination in the same manner as from the inoculated guinea-pigs. Whilst we consider that the elements which we observed in the blood of these six animals could not with certainty be distinguished from the yellow fever parasite, we can definitely state that in none of these cases were any of the more advanced forms of *P. flavigenum,* which we have described in this paper, found in touch-preparations from the internal organs.

Thirty-nine stock guinea-pigs which died before inoculation were examined post-mortem. The result was entirely negative in thirty-one, i.e., the gastric mucosa appeared to be normal, there was no albuminuria, and the organ touches showed no parasites. Three of the other animals exhibited only erosion of the stomach, the appearance of the lesion strongly suggesting post-mortem digestive changes. A small haemorrhage was present in the stomach of another guinea-pig, and two animals showed albuminuria but no affection of the gastric mucous membrane. The remaining two cases require some discussion. The first of these died at an early period

of our work, and the blood had not been examined in life. At the post-mortem examination there were hyperaemia and haemorrhages in the stomach, albuminuria was present, and 'blue bodies' were found in liver and bone-marrow touches. The second case was that of a guinea-pig which had been used for feeding mosquitoes in the room which we had prepared for the breeding of these insects. The blood-examination beforehand had proved to be negative, and at the end of about two months this animal died. The post-mortem revealed the presence of gastric haemorrhages and of albuminuria, whilst blue bodies were found in the lung, liver, and spleen touch-preparations. Another guinea-pig, whose blood was also free from parasites before being put into the mosquito-house, inhabited the same room and fed the same mosquitoes for the same period of time, and died shortly after the first. The post-mortem findings in this case were negative.

The parasite found in these cases may have been quite a different one, perhaps another representative of the *Babesiidae*. But the morphological resemblance, and the presence in the hosts of pathological lesions similar to those observed in the yellow fever infected animals, made us regard it as more likely that the animals had really been infected with *P. flavigenum*. If this is so, the authorities may be right who (Manson and Licéaga) have suggested that endemic yellow fever might be kept up in animals—and the question of prophylaxis would be further complicated. We wish to add, however, that we see no epidemiological reason why this hypothesis should be accepted. Whilst we admit the possibility of this source of infection, we believe that it would in practice prove to be a non-important one.

It is difficult to explain the mode of infection in the two guinea-pigs whose history has just been described, and also in the six guinea-pigs which were eliminated from the experiments.

The infection may have been a chronic or latent one, its inception dating back to some time before their arrival at the Institute. Infection during transit from their place of origin must also be considered. The possibility of other insect hosts, such as fleas and lice, must be borne in mind.

And finally, the question of hereditary transmission by *Stegomyia fasciata* cannot be excluded in the case of the guinea-pig

which was used to feed the newly-hatched mosquitoes in the breeding-house, although this theory is not supported by the negative post-mortem results obtained from the other guinea-pig which occupied the room during the same period.

Discussion of results obtained

The disease produced in guinea-pigs by injecting blood recovered from yellow fever patients and containing *P. flavigenum* shows a very striking resemblance to yellow fever in the human subject. It is characterised by pyrexia, haemorrhagic gastritis and albuminuria. Hyperaemia of various organs, more especially of the liver and lungs, is common. There is a constant absence of splenic enlargement. The histological conditions of the organs have so far been investigated in a few cases only, but it would appear that they show a much less marked correspondence to the lesions observed in the human cases. The infection can be transmitted by injection of blood from one guinea-pig to another for what appears to be an indefinite number of generations. *P. flavigenum* was found in all the inoculated guinea-pigs except a few, which were insufficiently observed, and it is quite possible, in view of our later experience, that these animals also would have shown parasites had the observations been continued for a longer period. The forms of the parasite observed in the peripheral blood were identical with those found in the blood of yellow fever patients. They were, as a rule, very scarce, thus corresponding in this particular also to the conditions obtaining in human infections. No process of division could be demonstrated directly in fresh specimens, or by combination of forms found in dried films, but a certain number of individual forms were seen to possess from two to four chromatin granules. This, considered with the corresponding forms described by one of us (Seidelin, 1912, Pl. I, fig. 21) in human cases, suggests that occasionally a partial or complete division takes place in the peripheral blood. So far, no new facts had been observed with regard to the parasites. We learned no more from the examinations of the peripheral blood in our guinea-pigs than we had known beforehand. The examination of organ-touches proved more successful. The forms which have

been described above were strikingly different from those observed in the peripheral circulation. So different were they, in fact, that the question arose whether they were of an entirely different nature. Their parasitic origin could not be doubted, their morphological characters pointing so distinctly to a protozoic organism; but the possibility had to be considered of their representing other spontaneously-occurring parasites. We had to consider this question very seriously, because the parasites show a certain resemblance to the elements first observed by Chagas (1909) in guinea-pigs' lungs, and regarded by him as a stage in the evolution of *Trypanosoma cruzi*, whilst it has later been declared by others (see Aragao, 1913) to be a lung-parasite of guinea-pigs with no relationship whatsoever to the trypanosome.

Our elements are evidently not identical with those described by Chagas, but there is the possibility that they might belong to the same group. We believe, however, that we can discard this hypothesis*. Two important factors are against it. One reason is that we have, as far as we can judge by the morphological characters, found transitional stages from small intracorpuscular elements to the fully developed dividing forms, the intermediate stages being intracorpuscular bodies larger than the initial ones, and free bodies smaller than the fully developed elements. These initial bodies show great resemblance to ordinary forms of *P. flavigenum*, and if this interpretation of our observations be correct, then we have to do with a blood parasite, and not with one of the lung. The correctness of this view is confirmed by the frequent finding of similar though not fully developed forms in other organs, especially in the spleen, and by the occasional finding of advanced stages of division in various organs. Secondly, we never found the same parasite in non-infected guinea-pigs, although a considerable number of these died and were subjected to a careful post-mortem examination, as above stated.

The only objection, we believe, which can be raised against our view of regarding these division forms as a link in the life-cycle of *P. flavigenum* is that they have been found neither in human

* The hypothesis of a mixed infection may, however, be admitted. The 'sporulating bodies' might differ essentially from the 'blue bodies'; in the case of the latter we believe that we can safely exclude the possibility of their being lung-parasites, whilst in the case of the former the question must at present be left undecided. For further discussion of this point see also Seidelin: Division forms of parasites in the organs of guinea-pigs infected with *Paraplasma flavigenum* (*Journ. Pathol. & Bacteriol.*, Cambridge, Jan., 1915, XIX, 3, pp. 338-340); and Connal and Johnston, Natural infection of guinea-pigs (*infra*, pp. 595 sqq.).

organs nor in the organs of other animals experimented upon. Further researches will have to be carried out in this connection, in view of our observations on guinea-pigs, but at the present time it appears that the objection is of no great importance. A comparison with the plates in several of Seidelin's earlier publications will show that, as a matter of fact, elements closely resembling the intracorpuscular and some of the extracorpuscular forms of blue bodies have already been figured without their true importance having been realised. The failure to find the more advanced stages in the human host may be explained in different ways. These stages are comparatively scarce, and they seem to occur only at certain periods; besides, they appear to change soon after death, as we have found them only in those cases in which the post-mortem has been made immediately or shortly after the death of the animal. Any of these circumstances would easily account for the absence of the division forms in earlier observations.

It appears, as far as our data go, that the formation of 'blue bodies' may start in various organs of the body, but that their complete evolution can only take place in the lungs. Possibly further research will show that it may occur also in the spleen. Their occasional appearance in the peripheral blood may depend either on their exceptional formation there, or upon their being casually washed out from the internal organs by the blood-current. The morphological appearances of the 'blue bodies' suggests that they are sexual forms, gametocytes. One would, however, *a priori* feel inclined to adopt the view that in a mosquito-transmitted disease the sexual evolution of the parasite would take place in the insect-host, especially as there is some reason to believe that under ordinary conditions the transmission takes place only after a certain period of evolution of the parasite in the mosquito. On the other hand, this preconceived idea may be erroneous, and it may here be mentioned that Finlay (1903) suggested many years ago that the conditions in yellow fever are probably the reverse of those obtaining in malaria, i.e., that in yellow fever the sexual stage of the parasite would be found in the human host and the asexual stage in the mosquito. Adopting the first view, the morphological appearances of the 'blue bodies' would correspond quite well to the theory of a double schizogonic process, the first stage being the formation of eight elements secondarily sub-dividing, probably

inside the same 'cyst-membrane,' into a very large number of exceedingly minute merozoites. This discussion is at the present moment entirely theoretical, but it would appear that the following hypothesis possesses a certain probability. The parasites are present, to begin with, in the blood-stream as more or less irregular 'ring,' or 'pear,' or 'rod' shaped forms, and they divide, in the blood corpuscles, into four or five merozoites which infect other red-cells. Some of these newly-formed elements are compact, and develop no clear space in their interior. They retire into the internal organs and grow to a relatively excessive size; earlier or later they become free and divide into eight elements. These elements remain inside the original membrane of the 'blue body,' and undergo a second division, the result being the formation of minute elements which become free and presumably pass into the blood-current where they would have a chance of being taken up by mosquitoes. Several additions must be made to this hypothesis. The 'blue bodies' appear to leave the erythrocytes at very different stages of their development, some becoming free whilst still of a small size, others not doing so until they appear about fully developed. In some cases it would appear that even the division may take place inside the remains of an erythrocyte, as several fully developed forms have been seen in which the 'membrane' shows a staining very similar to that of haemoglobin, thus giving the impression of representing the remains of almost completely digested erythrocytes. The 'blue bodies' may become phagocytosed by mononuclear leucocytes at any stage of their evolution. Whether they can continue their development in the leucocytes we have no means of discussing. The 'blue bodies' would appear to belong to two groups, those with a pale protoplasm and fairly abundant chromatin, which as a rule occupies a peripheral position, and those with a more deeply blue-staining protoplasm and a scanty loose centrally-placed chromatin mass. This, as mentioned above, raises the question whether a sexual process takes place in the human host.

Conclusions

The yellow fever parasite, *Paraplasma flavigenum* (Seidelin, 1911), has been transmitted to guinea-pigs and monkeys by direct inoculation of blood.

The infection has been carried seriatim through twenty-three guinea-pigs.

The peripheral blood of the infected animals contains forms of the parasite identical with those occurring in human blood in yellow fever.

Various internal organs of the infected animals, particularly the lungs, contain elements which we have found good reason to regard as division forms of *P. flavigenum*.

No conclusive results have been obtained by mosquito experiments or by blood cultures.

In all our experimental work we received valuable assistance from Sergeant F. G. Phipps, R.A.M.C., who had the general supervision of the laboratories and of the animals, and who always personally and with great care measured the temperatures of the animals in observation.

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EXPLANATION OF PLATE VIII

All figures have been drawn from Giemsa-stained preparations, by means of Abbe's drawing apparatus. The system used was as a rule Zeiss's apochr. imm. obj. 3 mm., with comp. oc. 12, but sometimes Zeiss's apochr. 1·5 mm., with comp. oc. 6 or 8, and in a few instances Reichert's achrom. 1/12″ with oc. 4. A nearly uniform magnification of 1400-1500 lin. was obtained by varying the height of the drawing table.

Figs. 1-4. *P. flavigenum* in blood from human case L. 73.

Figs. 5-6. *P. flavigenum* in blood from Guinea-pig 143, inoculated from L. 73.

Figs. 7-10. *P. flavigenum* in blood from Guinea-pig 148, inoculated from Guinea-pig 143.

Figs. 11-14. *P. flavigenum* from Guinea-pig 150, inoculated from Guinea-pig 148.

Figs. 15-16. *P. flavigenum* from Guinea-pig 154, inoculated from Guinea-pig 150.

Figs. 17-25. *P. flavigenum* in blood from various inoculated guinea-pigs.

Figs. 26-28. *P. flavigenum* in organ-touches from inoculated Guinea-pigs (26 and 28 lung, 27 bone-marrow).

Figs. 29 and 49-52. Intracorpuscular 'blue bodies.'

Figs. 30-46 and 53. Extracorpuscular 'blue bodies.'

Figs. 47 and 48. Elements of doubtful nature, possibly resulting from further division of the 'blue bodies.'

Fig. 54. Phagocytosis of 'blue bodies.'

Fig. 55. Phagocytosis of erythrocyte containing a parasite.

Figs. 29-48 and 51-55 are all from organ-touches from inoculated animals. Figs. 34-46 and 51 are from lung; 30, 31, 47, 48, and 52 from spleen; 29, 32, 33, 54, and 55 from liver, of guinea-pigs. Fig. 53 from spleen of monkey. Figs. 49 and 50 are from the peripheral blood of guinea-pigs.

PLATE VIII.


1 2 3 4
5 6 7 8 9 10
11 12 13 14 15 16
17 18 19 20 21 22
23 24 25 26 27 28
29 30 31 32 33 34 35 36 37
38 39 40 41 42 43
54
44 45 46 47 48
50 51 52 53 55

REPORT ON THE EXAMINATION OF THE BLOOD OF TWENTY-FIVE NORMAL GUINEA-PIGS FOR THE PRESENCE OF 'SEIDELIN BODIES'

BY

D. THOMSON, M.B., Ch.B. (Edin.), D.P.H. (Cantab.).

The guinea-pigs examined were obtained in England, and varied in age. The blood films were obtained from the ears of the animals. All were fixed in methyl alcohol for 15 minutes and stained with Giemsa 1 in 15 for half an hour.

In all the guinea-pigs except four, bodies resembling Seidelin's yellow fever parasites were found. Sometimes they were very scarce, only one being found after an hour's search, but this depended to some extent on the personal factor. As a rule one fairly definite body containing a red chromatin dot, with a bluish tag or ring attached, could be found within the hour, but during this hour of searching one came across several other bodies, bearing some resemblance to a Seidelin body, and which no doubt some observers would have depicted as such. Since completing this work on normal guinea-pigs I have examined carefully several of the marked blood films sent home by Dr. Seidelin, showing the supposed yellow fever parasites in inoculated guinea-pigs. Nearly all of the bodies shown in his specimens are more indefinite than I had imagined they would be, and in fact, in my examination of normal guinea-pigs' blood, I have seen several such bodies, but have passed them over as artefacts and too indefinite to paint.

The bodies which I found in normal guinea-pigs bearing a marked resemblance to Seidelin's paintings are depicted in the accompanying coloured plate. In figs. 1-4 signet ring forms are depicted, bluish rings, with a chromatin-like dot on the margin. In some of the signet ring forms, the colour of the ring was reddish instead of blue, figs. 11-15. The second group consisted of a chromatin-like dot with a bluish tag of protoplasm attached as seen in figs. 16-22. Some of these were found free from the red cells, vide figs. 23 and 24. The third group consisted of a bluish circle with the chromatin dot in the centre as in figs. 5-10. The fourth variety consisted of an elongated bluish streak with a chromatin dot in the centre or at one end, some of these were free,

vide figs. 25-28. The fifth group consisted of reddish granules made up of a dark and lighter staining parts as depicted in figs. 29-35. The bodies belonging to this latter group were fairly numerous.

With regard to the nature and origin of these bodies one cannot make any dogmatic statement, but it is highly probable that they arise from various sources. Without doubt the great majority of them are artefacts, and cannot be considered as protozoal in nature, though some of those consisting of a reddish ring with a darker staining centre may possibly be an early stage in the *Lymphocytozoon cobayae* (Kurloff bodies), which was found in practically all of the guinea-pigs examined. The most common origin of the majority of the bodies of the first three groups I consider to be a chance combination of dust, dirt or stain deposit. Stain deposit produces chromatin-like granules, and also, at times, bluish rings of varying size. However clean one may try to make the slide, it is not possible to exclude this source of artefact. In taking blood from a guinea-pig's ear, the film is very liable to be contaminated with epithelial débris, etc., which would take on a bluish stain. Another source of these bodies might be a scratch in the red corpuscle. The leucocyte shown in fig. 38 shows a possible source of chromatin dots, and that shown in fig. 37 shows another possible source of a complete 'Seidelin body.' A probable organismal source is a type of bacillus, which, when stained with Giemsa, shows a definite blue protoplasm, containing a definite chromatin dot in the centre or at one end, vide figs. 26, 27, and 28. This bacillus might explain the origin of group 4. These bacilli are commonly found in the faeces of guinea-pigs and may easily get on to the blood films from the skin or hair of the animal. I have noticed on occasions that the bodies are sometimes removed from the red cells by cleaning the slide with xylol; this would support the artefact hypothesis. Finally, with regard to the bodies found by Dr. Seidelin in human yellow fever blood, another possible source might be the minutest forms of spores of the malignant tertian malaria parasite. In cultures of this parasite, exceedingly minute spores are found consisting of a chromatin dot with a blue tag of protoplasm and also some exceedingly minute ring forms similar to those depicted in Seidelin's coloured plates.

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EXPLANATION OF PLATE IX

Figures painted from Giemsa stained blood films of 25 healthy English guinea-pigs. Outline of figures obtained by using a Leitz drawing apparatus. Magnification about 1800 diameters.

Figs. 1-4. Show signet-ring forms of 'Seidelin bodies' within the red corpuscles (blue ring with chromatin dot on margin).

Figs. 5-10. Show bluish bodies with a chromatin-like dot in the centre.

Figs. 11-15. Show ring forms in which the body is of a reddish colour.

Figs. 16-22. Show forms consisting of a chromatin-like dot with a tag of blue attached.

Figs. 23 and 24. Show similar forms lying free.

Figs. 25-28. Show elongated bluish streaks with a chromatin-like dot in the centre or at one end.

Figs. 29-35. Show corpuscles containing reddish granules.

Fig. 36. Shows a bluish body containing red granules.

Fig. 37. Large mononuclear leucocyte with a projecting tag of nuclear chromatin and protoplasm. This suggests a source of 'Seidelin-like bodies.'

Fig. 38. Lymphocyte containing red granules. These might also form a source of 'Seidelin-like bodies.'

PLATE IX.

. Thomson pinx.

FURTHER REPORT ON EXPERIMENTAL TRANSMISSION OF *PARAPLASMA FLAVIGENUM*

BY

HARALD SEIDELIN, M.B. (Copenhagen), M.D. (Mexico); *Scientific Secretary, Yellow Fever Bureau, School of Tropical Medicine, University of Liverpool.*

On leaving Nigeria I brought with me on board s.s. 'Falaba' two infected and ten non-infected guinea-pigs. The two infected animals were g.-p. 337 and g.-p. 348, which had been inoculated on February 4th, 1914, the day before sailing, from g.-p. 346, of the series reported by Seidelin and Connal.* On board ship the guinea-pigs were kept in mosquito-proof cages, to begin with on the boat-deck, later on, during the cold weather, in the wheel-house. During the voyage serial inoculations were made, for which purpose the ship's surgeon, Dr. Ryan, kindly rendered valuable assistance. Two of the inoculated, and four non-inoculated animals died on board ship; it was unavoidable that the animals were exposed to somewhat sudden changes of temperature, to draughts, and to the close atmosphere of the wheel-house. No blood examinations were made on board, but post-mortem examinations were made in the inoculated and in two of the non-inoculated animals; of the former, the results are given below; in the latter cases, pulmonary hyperaemia and in one case commencing consolidation were the only organic lesions observed; the urine in the one case contained no albumen, and in the other case could not be examined, as the amount found in the bladder was too small.

On arrival at Plymouth, four inoculated guinea-pigs were sent to Colonel Sir W. B. Leishman†, and in Liverpool the two remaining animals were taken to the Pathological Department of the University, where Professor Ernest Glynn kindly undertook to make the necessary inoculations, as I at that time had no licence for experimental work.

With Professor Glynn's permission I give a summary of the results obtained; the examinations of the blood and the post-mortem examinations were made by me, alone or in the presence of Professor Glynn.

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* *Vide* pp. 427-478 *supra*.

† *Vide* Harvey: 'Report on the Examination of Normal and Inoculated Guinea-pigs' (*infra* pp. 731-752).

Table I. Experiments on Board s.s. 'Falaba'

Guinea-pig No.	Inoculated from No.	Date	Date of death	*P. flavigenum* in blood	Blue bodies in organs	Stomach	Urine
337	346	4-II	8-II	...	...	Hyperaemia, one petechia	Albumen
348	346	4-II	10-III	Present	Present	Hyperaemia	Albumen
360	337	7-II	14-II	...	...	—	Albumen
358	360	10-II	sent to Sir W. B. Leishman				
359	360	10-II	sent to Sir W. B. Leishman				
357	358	15-II	sent to Sir W. B. Leishman				
354	348	21-II	28-II	Present	Present	Hyperaemia, Petechiae	Albumen
363	358	21-II	sent to Sir W. B. Leishman				

Table II. Experiments in Liverpool

Guinea-pig No.	Inoculated from No.	Date	Date of death	*P. flavigenum* in blood	Blue bodies in organs	Stomach	Urine
S I	354	26-II	6-IV	Present	Present	—	Albumen (faint)
S II	354	28-II	8-IV	Present	...	—	Albumen
G I	S II	4-III	30-III	Present	Present	—	Albumen (faint)
S III	G I	8-III	16-III (killed)	Present	Present	—	No albumen
G II	S III	13-III	2-IV	Present	Present	Hyperaemia Petechiae	Albumen
(S IV	died immediately after inoculation, probably because of rough handling.)						
S V	G II	24-III	22-IV	Not found	...	—	No albumen
G III	S V	30-III	19-IV	Present	Not found	Hyperaemia, Haemorrhagic erosions	Albumen
S VI	G III	6-IV	9-IV	...	Not found	—	Albumen (faint)
G IV	S VI	9-IV	...	Present	...	...	...
(S VII	G IV	16-IV	17-IV; collapsed a few hours after inoculation and died on the following morning. Lungs exceedingly pale; no other lesions. No albumen in the urine.)				
L I	G IV	16-IV; sent to Sir W. B. Leishman.					
S VIII	G IV	18-IV	28-IV (killed)	Present	Present	Hyperaemia	No urine in bladder
G V	S V	22-IV	...	...	...	...	...

I shall not enter into a discussion of the results obtained in this series of experiments; they are very similar to those obtained in West Africa. The infections were, perhaps, less intense than in the African experiments, if they are judged by the number of parasites present. Ordinary forms of *P. flavigenum* were apparently more scanty in the blood-films, and the 'blue bodies' were decidedly few in comparison with the fairly large number of these elements which we often found in organ touches in the Yaba Institute.

On the other hand, the mortality due to the infection has, so far, appeared higher in Liverpool, especially when we consider that no spontaneous deaths occurred amongst our non-infected animals. The two deaths which occurred immediately or very shortly after inoculation were certainly not due to the infection; S IV had probably been somewhat roughly handled by the attendant, and in the case of S VII I can suggest no other explanation than that of 'shock,' perhaps due to an irritation of the solar plexus, as the injection of blood was in this case made in the upper part of the abdomen instead of in the lower part as was usually the case. The apparently higher rate of mortality may possibly be due to the circumstance that most animals were observed for a longer time than those at Yaba, where we very often killed them after one or two weeks. Several deaths in this series took place after a month or more. The same circumstance may perhaps also explain the scarcity of the 'blue bodies' which we used to find most numerous in the lungs of animals which had been killed about six to ten days after inoculation. The material here dealt with is obviously too small to discuss these various questions; they require further investigation.

Another point which requires further investigation is that of the temperature reactions. Several of the animals showed what appeared to be very marked reactions, but serious doubt as to the importance of these reactions was produced by the statement made by Sir William Leishman that he had observed very high temperatures in non-inoculated animals, and perhaps, on the whole, lower temperatures after inoculation. Since then I have made further observations on this subject, always personally taking the temperatures. I have observed high temperatures also in non-inoculated

guinea-pigs, even above 104° F., though the highest temperatures recorded have been in inoculated animals. I am continuing these observations, but on the whole I should at the present time lay little stress on this symptom. It would appear that the temperatures of guinea-pigs in this country are, on the whole, considerably higher than those observed at Yaba, a point which likewise deserves special investigation. My impression is that the animals often show very high rises after inoculation, and sometimes also very low temperatures, but more especially that they show very considerable variations. It also remains to be seen whether the high temperatures observed in non-inoculated animals are due to insignificant causes, or whether they are due to disease. I have so far been unable to find out that these animals have been suffering from any disease; as mentioned above, no deaths have occurred spontaneously, and the animals appeared quite healthy.

The accompanying temperature charts illustrate the results obtained in inoculated and non-inoculated animals. It may be of interest to compare these results with some others obtained by various observers. Thus, Athanasiu and Carvallo (1898) have found 39·2° C. (102·6° F.) as an average of 119 observations, the minimum being 37·8° C. (100° F.), and the maximum 40·5° C. (104·9° F.). Pembrey (1898) summarizes various investigators' results:—

	Aver.	Min.	Max.
Finkler (about 50 observations)	38·7° C. (101·7° F.)	38·5° C. (101·3° F.)	39·4° C. (103° F.)
Pembrey (19 obs. on 5 g.-ps.)	37·93° C. (100·2° F.)	37° C. (98·6° F.)	39·2° C. (102·6° F.)
Richet (35 obs.)	39·21° C. (102·6° F.)	37·9° C. (100·2° F.)	40·2° C. (104·4° F.)
Colosanti (40 obs. on 4 g.-ps.)	37·4° C. (99·4° F.)	36° C. (96·8° F.)	38·5° C. (101·3° F.)
Pitts (30 obs. on 1 g.-p.)	38·85° C. (101·9° F.)	38° C. (100·4° F.)	39·6° C. (103·3° F.)

Tigerstedt (1909) admits variations between 37·4° C. (99·3° F.) and 39·2° C. (102·6° F.), and Tereg (1910) variations between 37·9° C. (100·2° F.) and 38·3° C. (100·9° F.). The latter author also quotes Finkler to the effect that the rectal temperature varies to such a degree according to the depth at which it is taken that whilst it is 36·1° C. (97° F.) at a depth of 2·5 cm., it is 38·7° C. (101·6° F.) at 6 cm., and 38·9 C. (102° F.) at 9 cm.

In connection with this work, my sincere thanks are due to Professor Glynn and to Dr. Ryan, and also to the Captain and Officers of the s.s. 'Falaba,' who took great interest in having the guinea-pigs well looked after during the passage.

Addendum.—Since the above was written, I have continued the experiments. Several cases of spontaneous death have occurred amongst the stock guinea-pigs, but very few in comparison with the high mortality amongst the inoculated animals. Post-mortem examination showed, in the non-inoculated animals, no characteristic anatomical lesions; slight albuminuria was sometimes present.

A coloured plate has been added to the paper. In this plate nothing essentially new is shown, except in a technical sense. Recent advances in technique have made it possible to give satisfactory reproductions of colour photographs. I have therefore thought that illustrations of this nature might be considered to possess a special documentary value, as eliminating the personal element. In this way the suggestion that the bodies described as *P. flavigenum* are artefacts may perhaps be finally disposed of. I have used two different methods of colour photography, namely Lumière's autochrome method and Paget's duplicating method. In my work the former has rendered the colours more correctly, but with the latter I have obtained a sharper definition. The best results have, as it might be expected, been obtained in the case of intensely stained, i.e., recently stained, specimens. The figures from specimens of earlier date, especially those from Yucatán, shown for comparison, are therefore not very sharp. In my opinion, this method is destined to become of great value in comparative work, especially as the duplicating technique makes it possible to prepare any required number of transparent positives, for demonstration.

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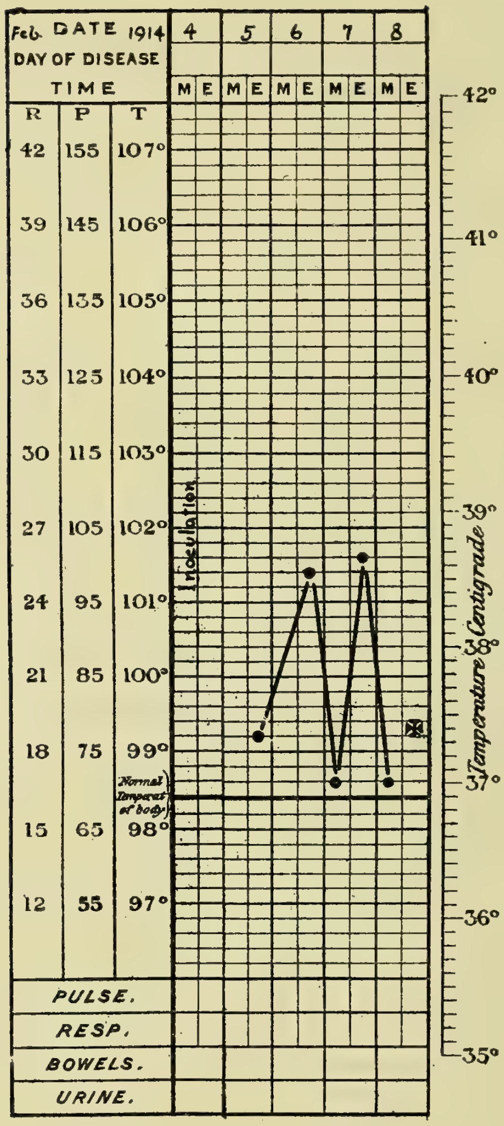

Chart 1—G.-p. 337 from 346
Yaba—s.s. 'Falaba.'

Post-mortem examination : Gastric hyperaemia and one minute petechia.

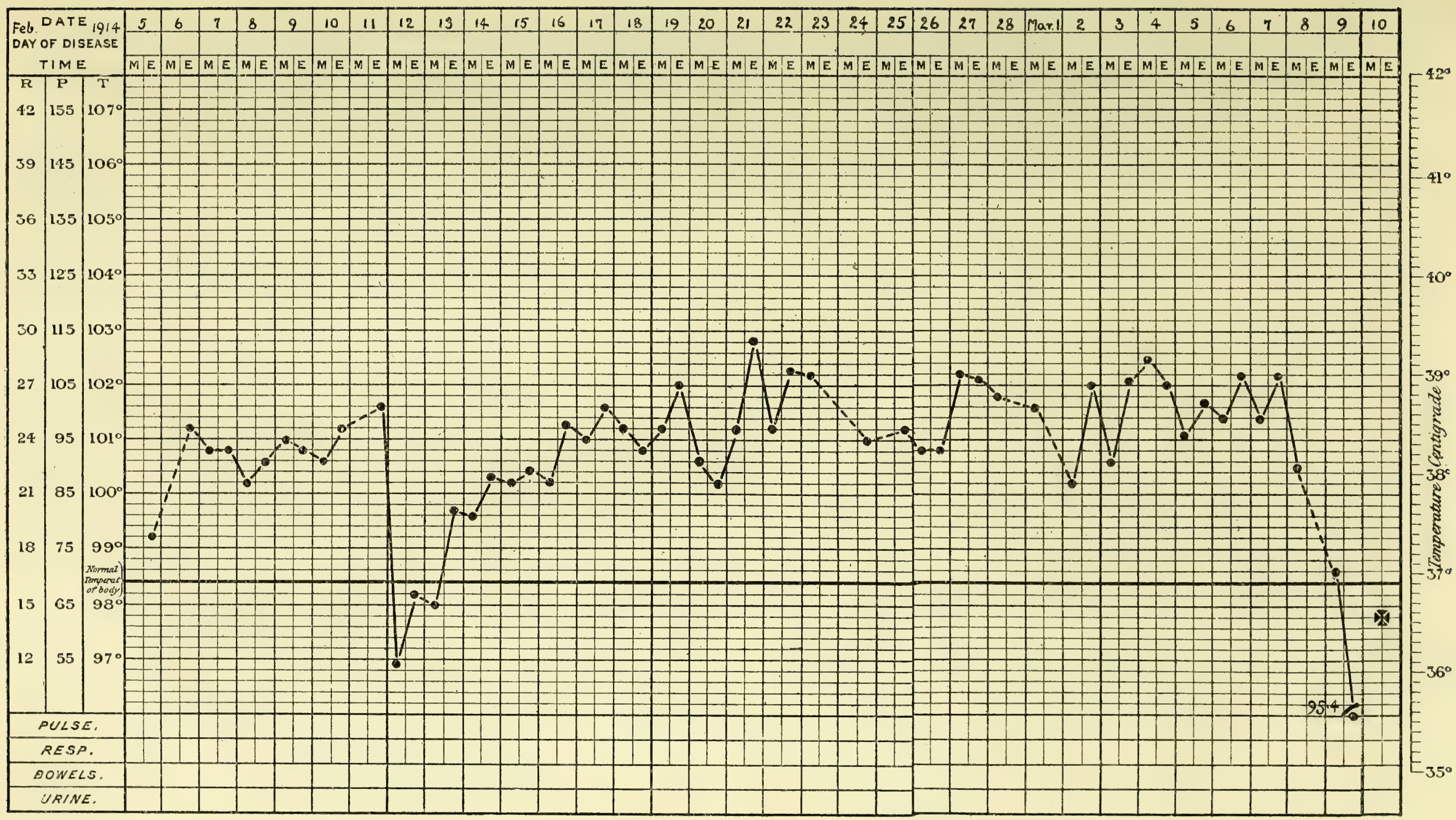

Chart 2—348 from G.-p. 346, inoculated Feb. 4

Yaba—s.s. 'Falaba'—Liverpool

Post-mortem examination : Slight hyperaemia of stomach, intense hyperaemia of duodenum, moderate hyperaemia of lungs, liver, and kidneys ; spleen pale, not enlarged ; urine clear, marked albumen reaction.

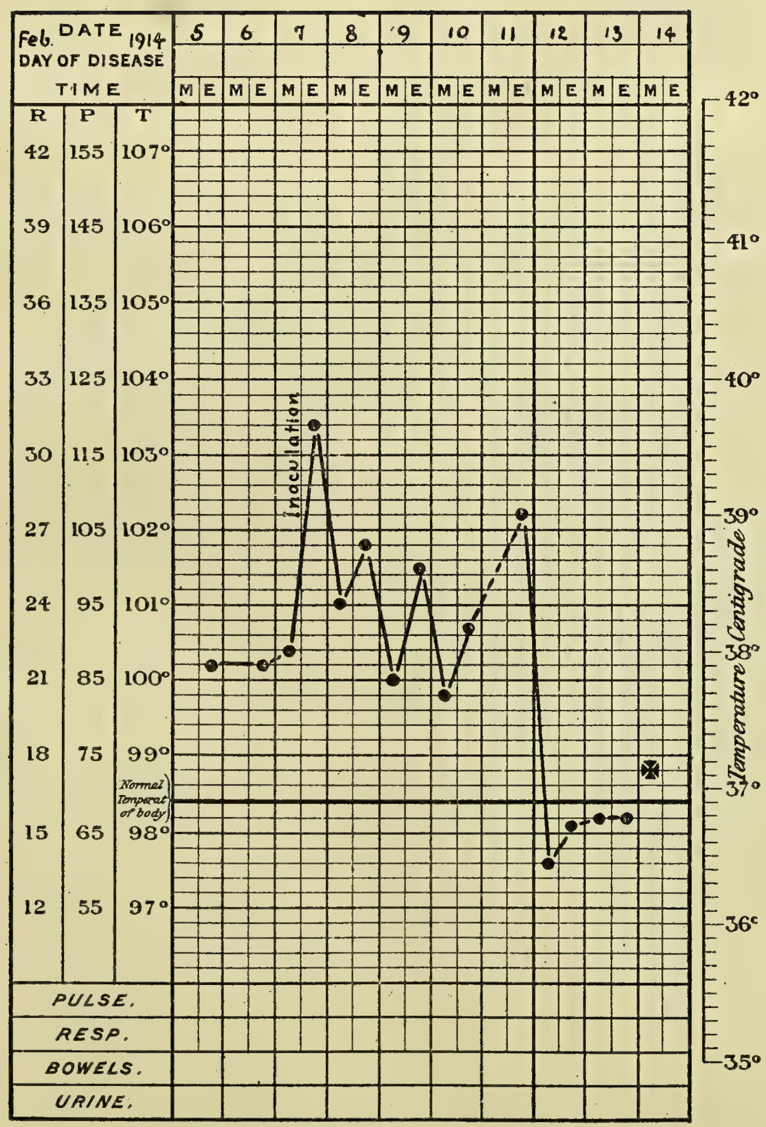

Chart 3—G.-p. 360 from 337
s.s. 'Falaba'

Post-mortem examination : Slight albuminuria, no other pathological phenomena.

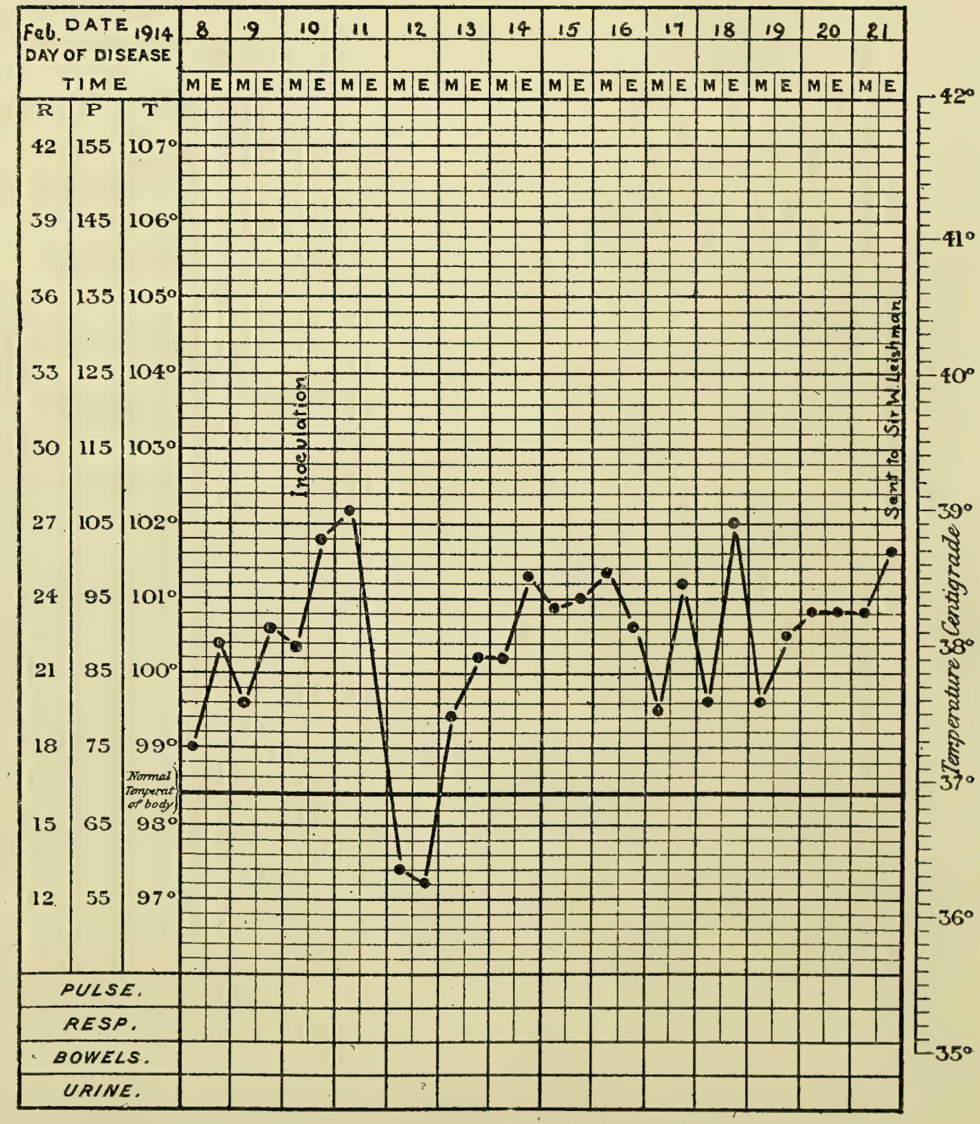

Chart 4—G.-p. 358 from 360
s.s. 'Falaba'

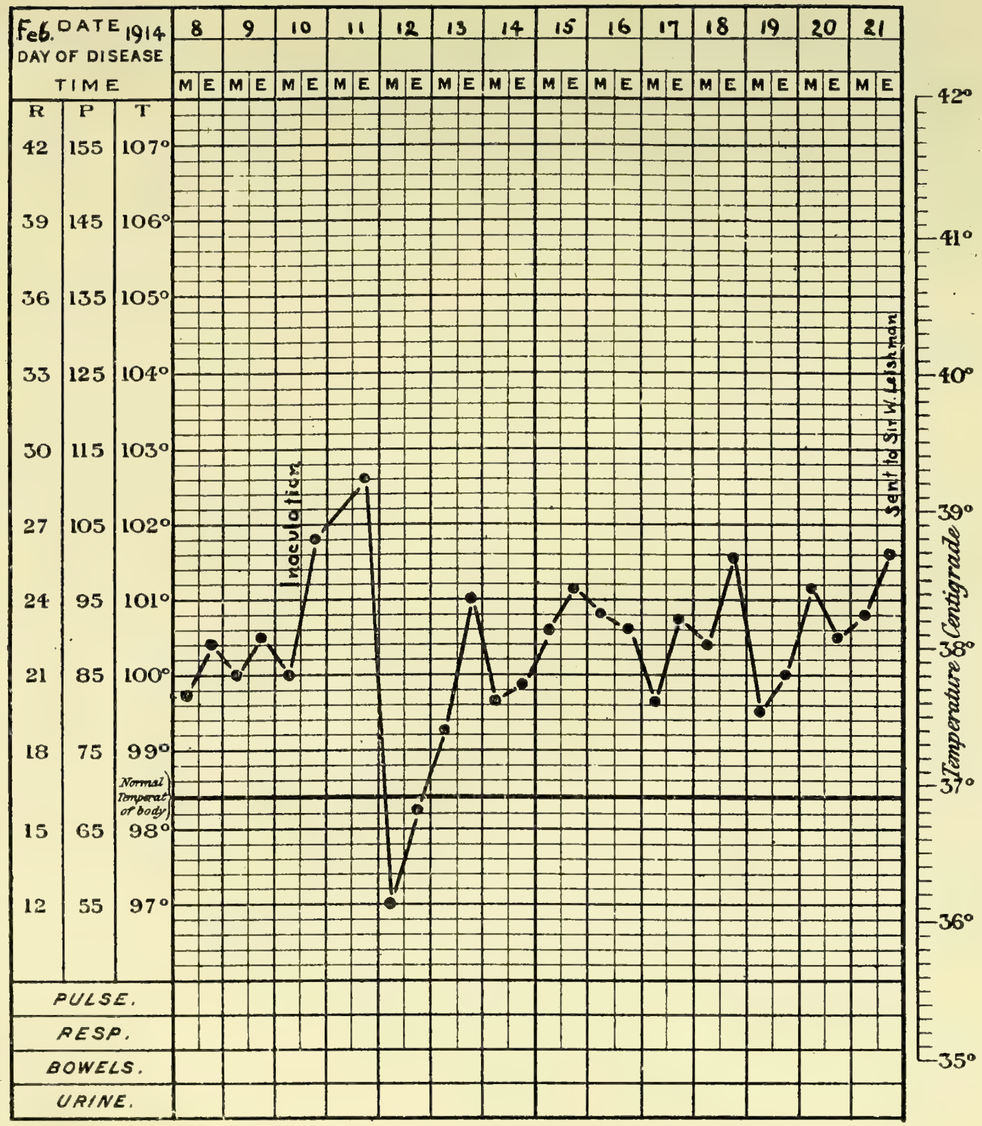

Chart 5—359 from 360
s.s. 'Falaba'

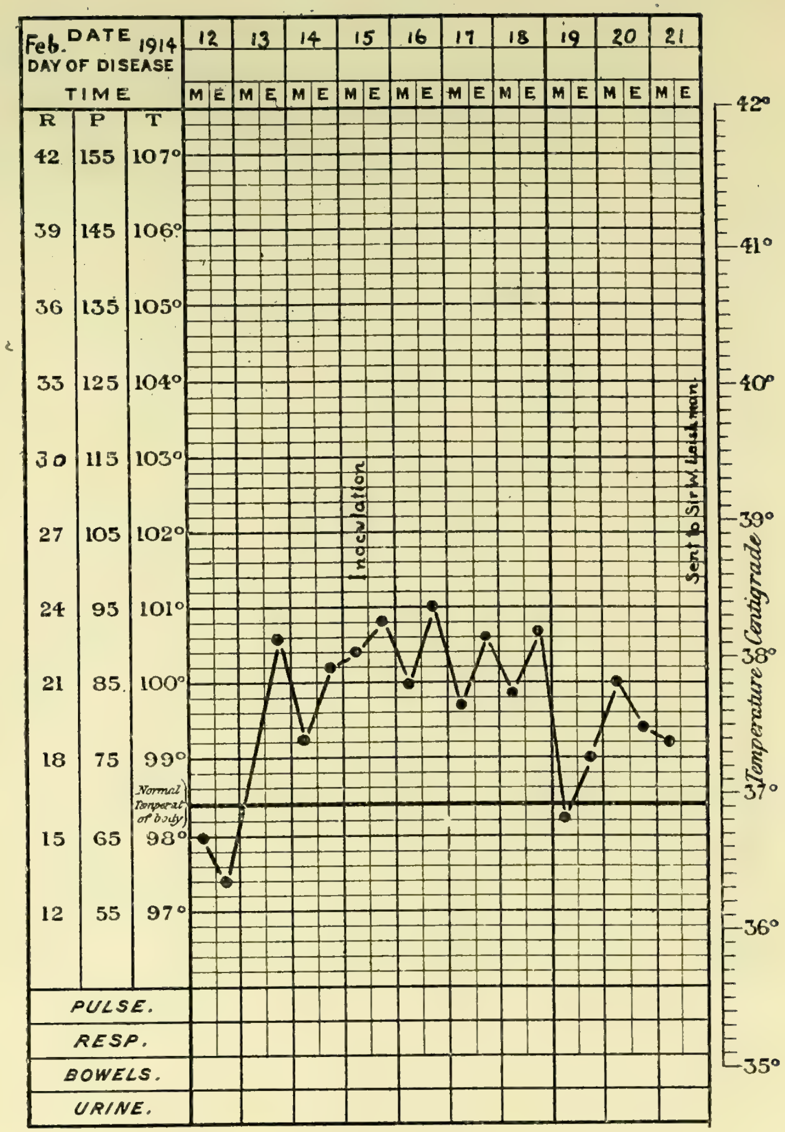

Chart 6—G.-p. 357 from 358
s.s. 'Falaba'

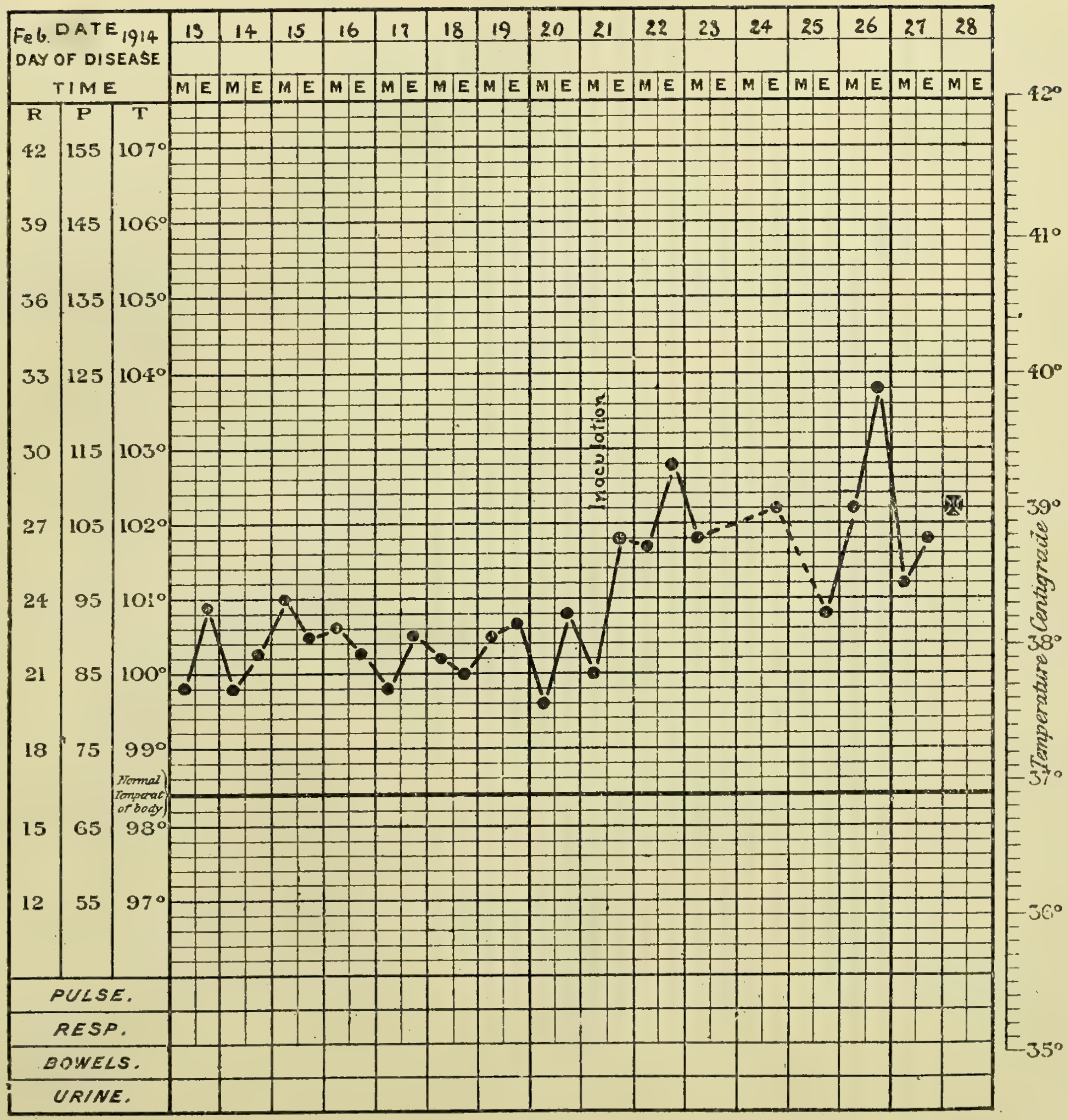

Chart 7—G.-p. 354 from 348
s.s. 'Falaba'—Liverpool

Post-mortem examination : Diffuse gastric hyperaemia and a few petechiae; hyperaemia of liver and kidneys, and slight hyperaemia of lungs; no enlargement of spleen; marked albuminuria.

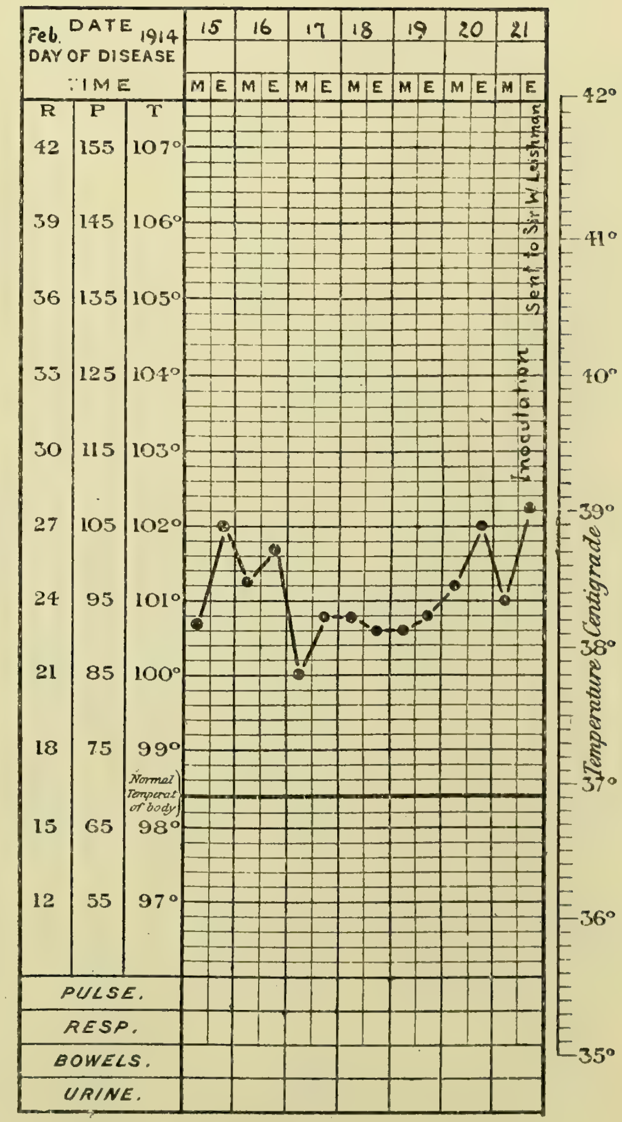

Chart 8—G.-p. 363 from 358
s.s. 'Falaba'

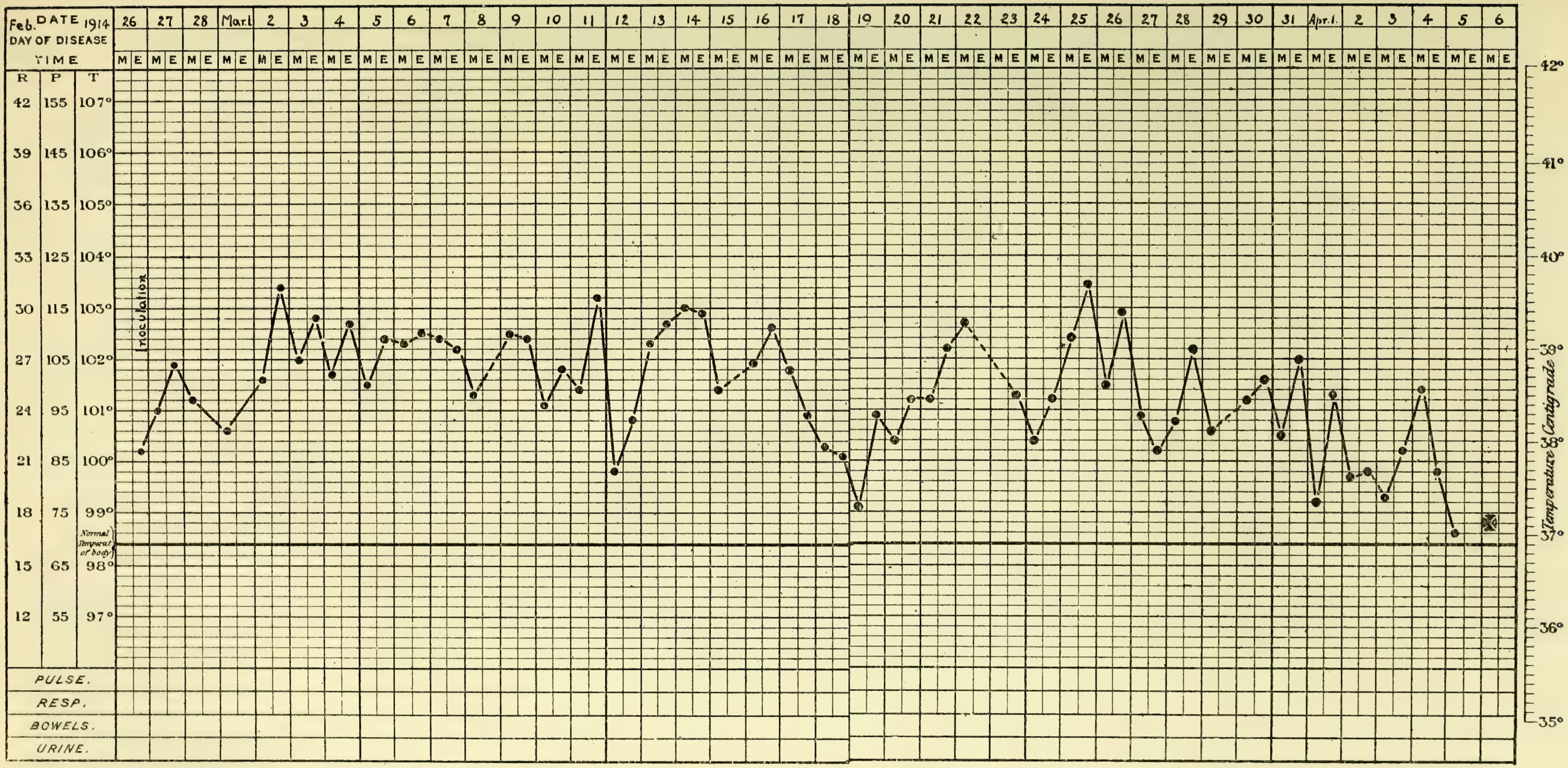

Chart 9—S I from 354. Liverpool

Post-mortem examination : Lungs hyperaemic ; kidneys slightly hyperaemic ; spleen pale, of normal size ; slight albuminuria.

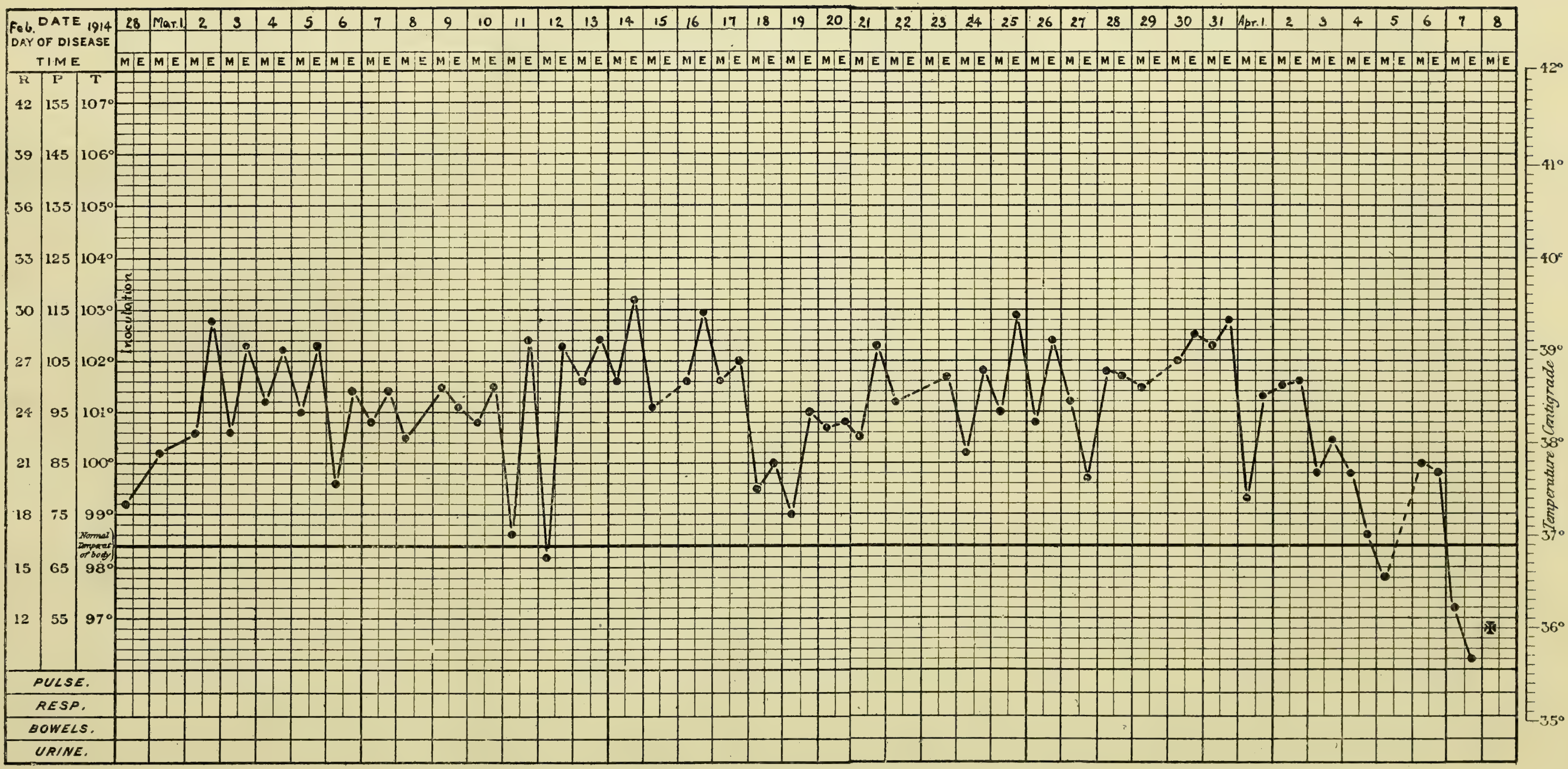

Chart 10—S II from 354. Liverpool

Post-mortem examination : Pleural ecchymoses ; lungs hyperaemic ; liver slightly pale ; spleen pale ; stomach normal ; intense albumen reaction in urine.

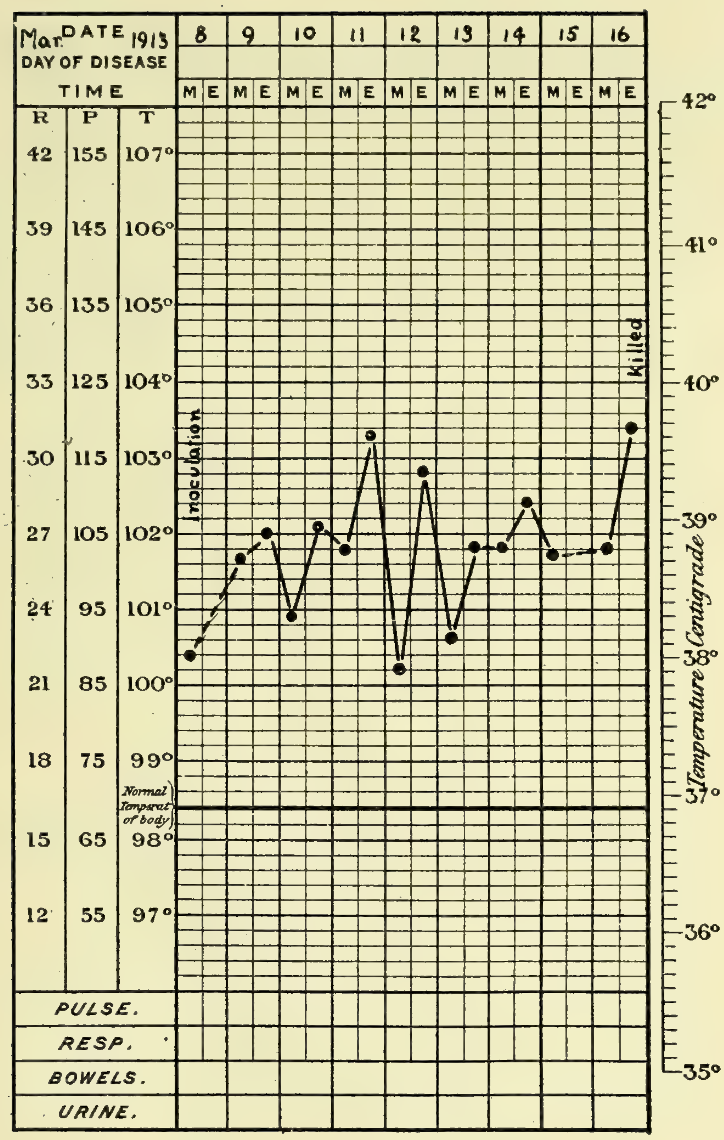

Chart 11—S III from G I
Liverpool

Post-mortem examination : No organic lesions; no albuminuria.

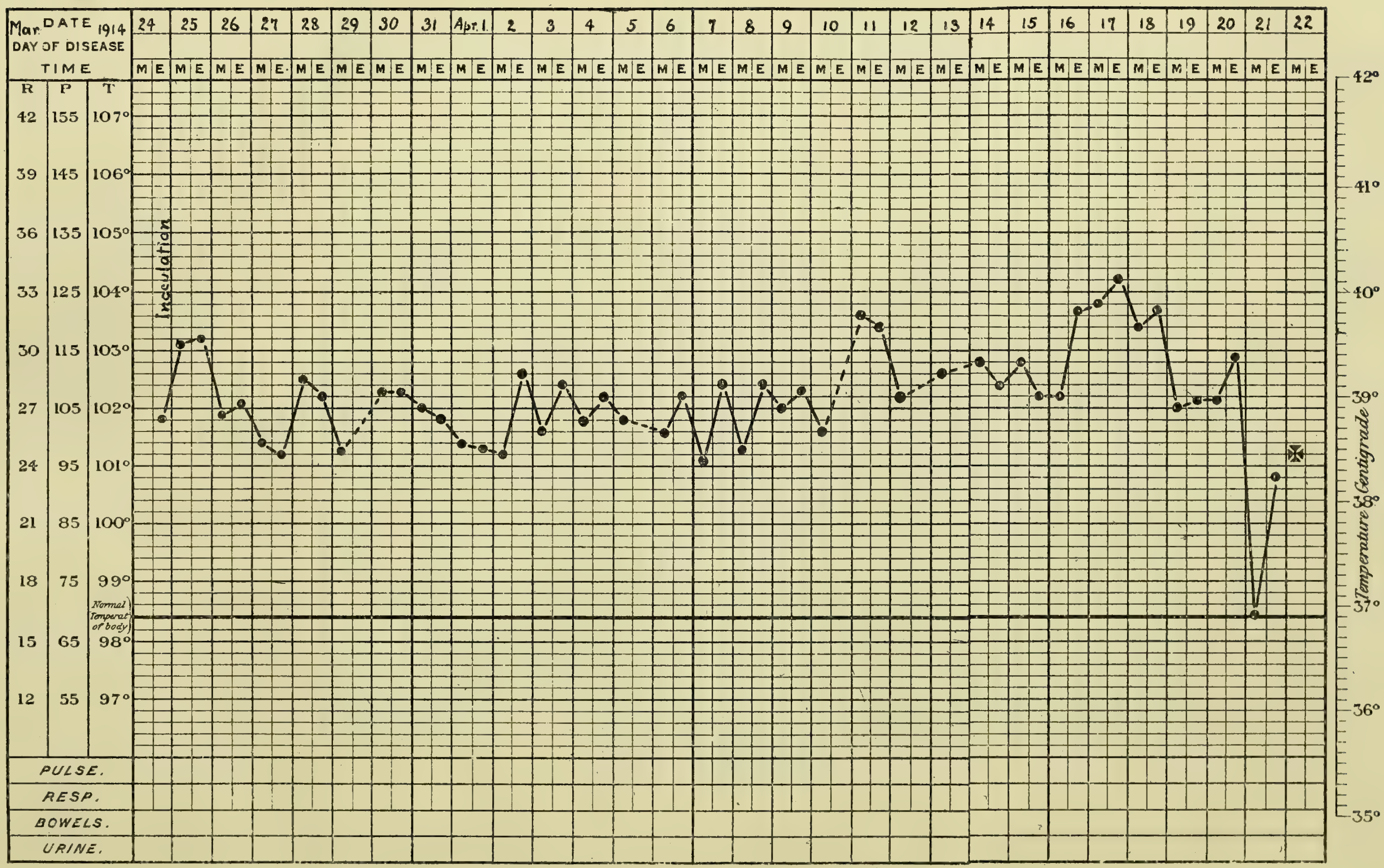

Chart 12—S V from G. II. Liverpool

Post-mortem examination: Emaciation; liver reduced in size, no other pathological phenomena; no albumen in urine.

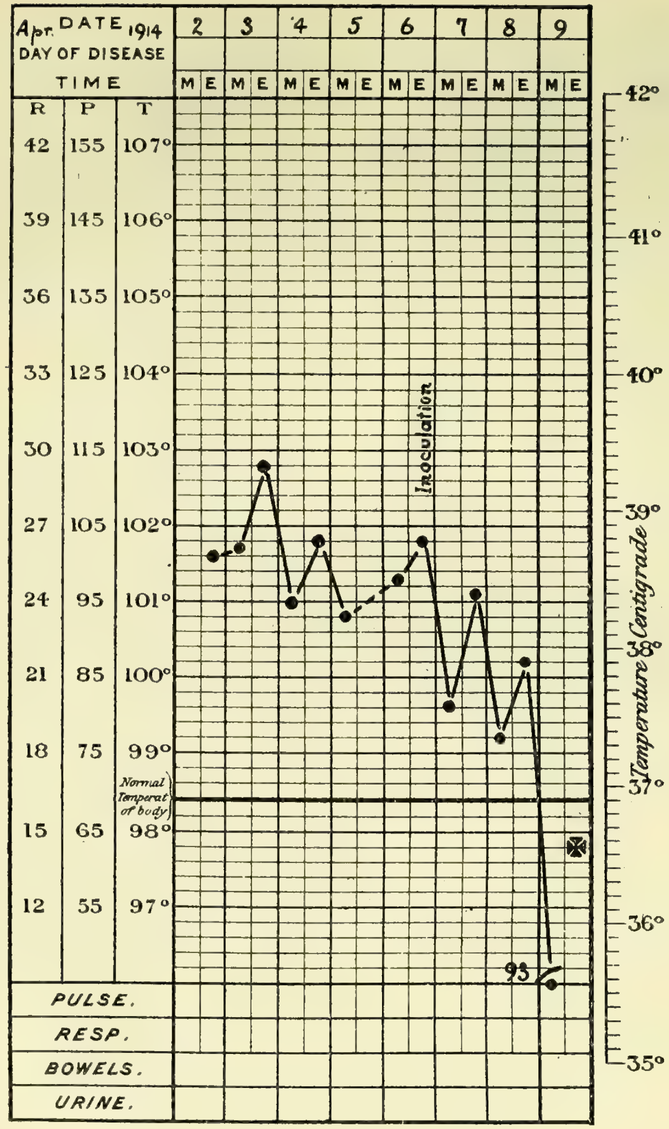

Chart 13—S VI from G III

Liverpool

Post-mortem examination : Slight hyperaemia of lungs; slight albuminuria.

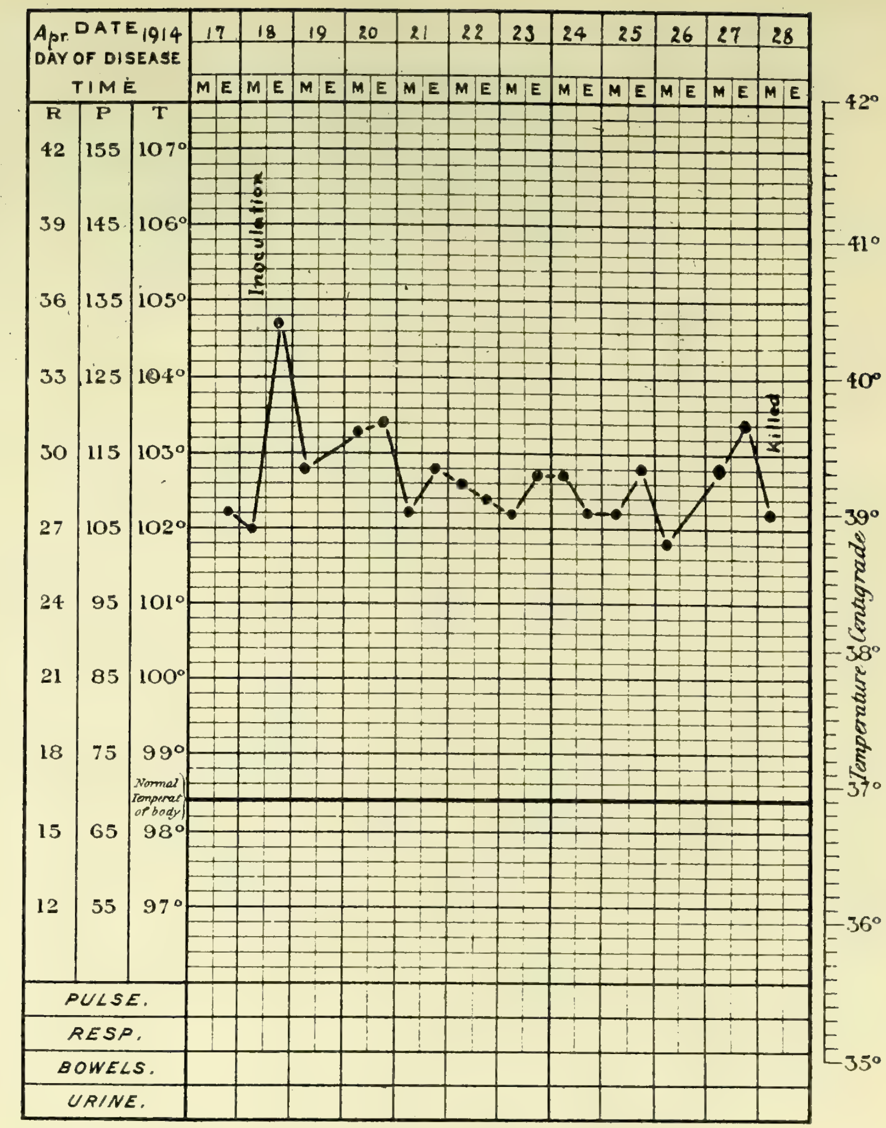

Chart 14—G VIII from G IV

Liverpool

Post-mortem examination : No marked pathological phenomena; no urine in bladder.

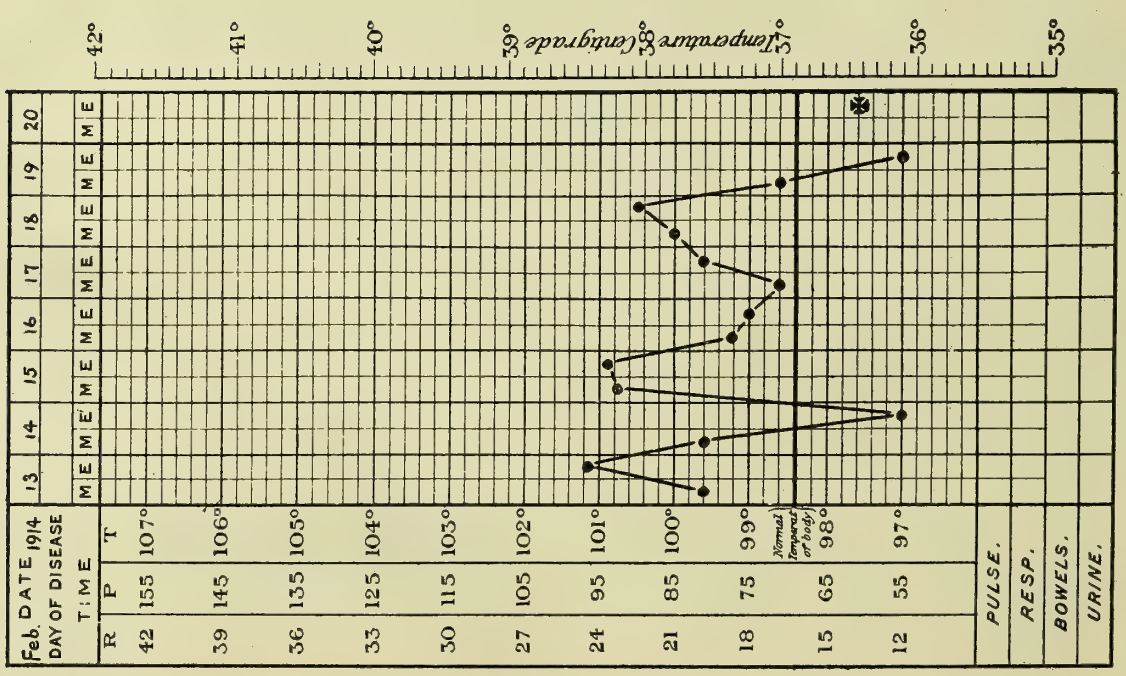

Chart 15—G.-p. 355. Non-inoculated
s.s. 'Falaba'

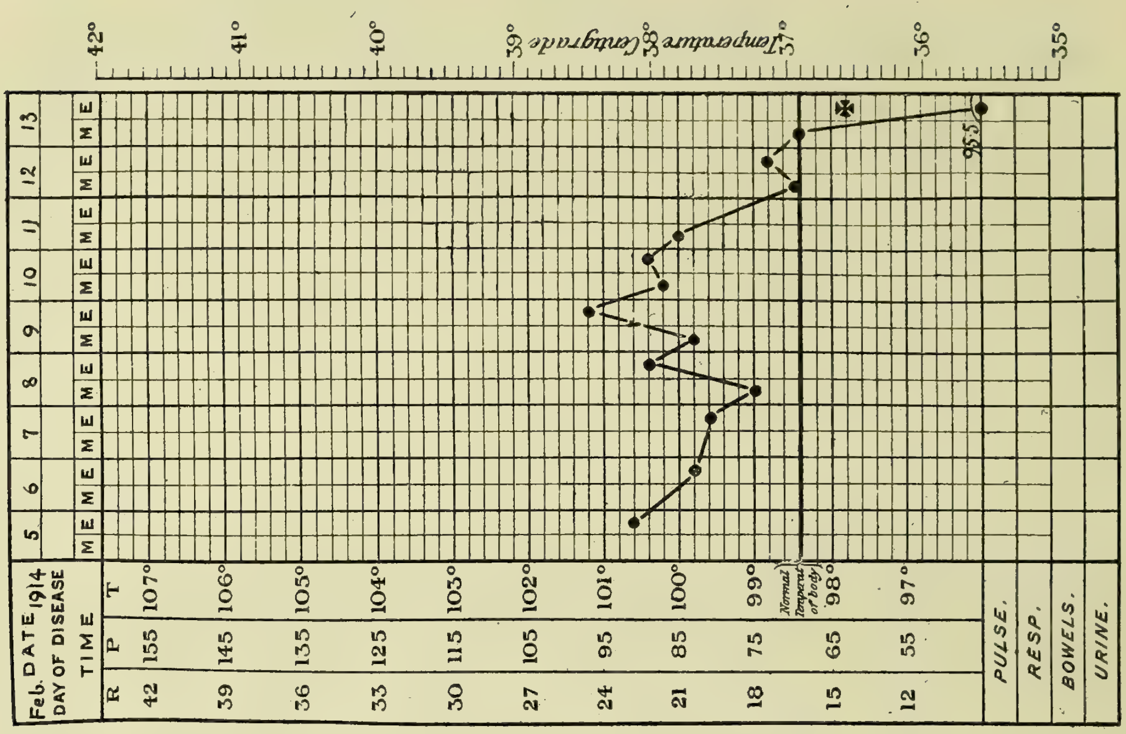

Chart 16—G.-p. 361. Non-inoculated
s.s. 'Falaba'

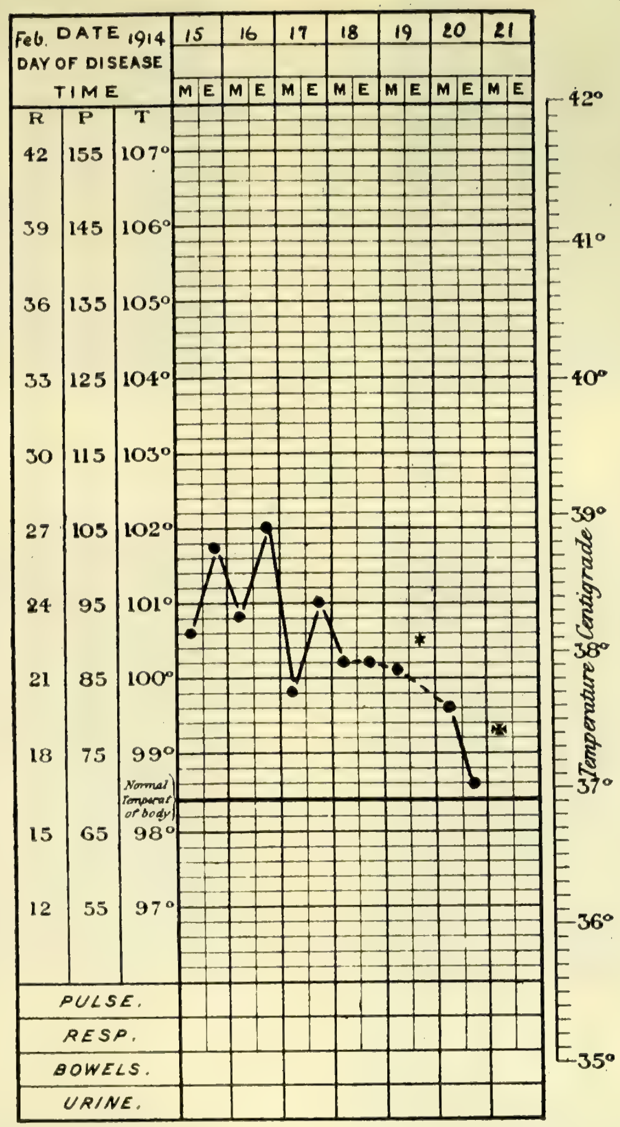

Chart 17—G.-p. 362. Non-inoculated
s.s. 'Falaba'

* Temperature not taken on account of collapse.

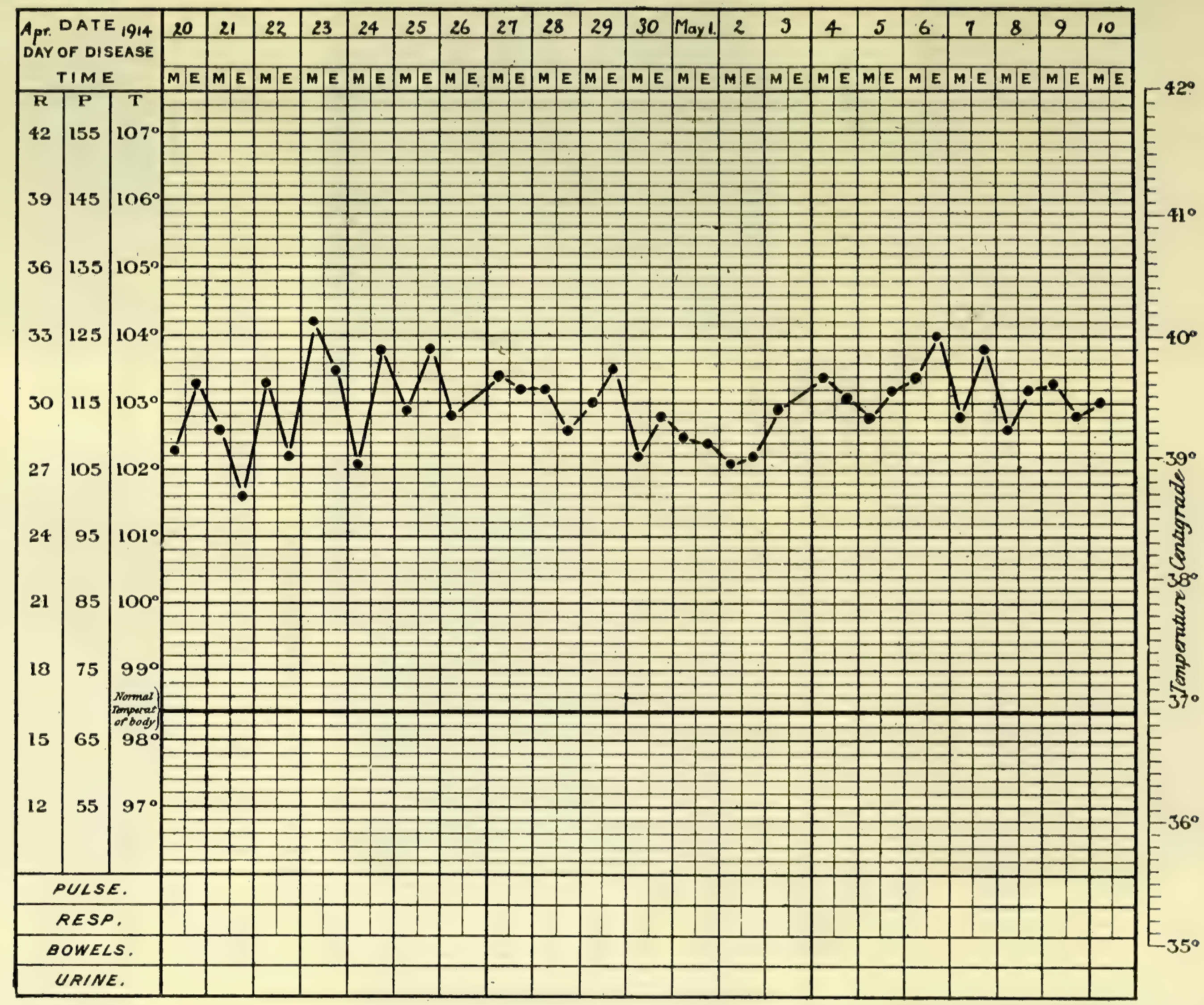

Chart 18—Stock 2. Non-inoculated
Liverpool

EXPLANATION OF PLATE X

All the figures have been reproduced from colour-photographs, figs. 1, 2, 10, and 11 from autochromes (Lumière), all others from 'duplicates' (Paget). The photographs have been taken by means of Zeiss's apochromatic objective 1·5 mm. and compensating eyepiece No. 8. Magnification 2300 lin. Giemsa stain.

Fig. 1. Yucatán. Human case. Peripheral blood. Initial form.

Fig. 2. Yucatán. Human case. Peripheral blood. Rod form.

Fig. 3. Yucatán. G.-p. II. Peripheral blood. Initial form.

Fig. 4. Accra. Human case. Peripheral blood. Ring form, with double chromatin.

Fig. 5. Yaba. G.-p. 239. Peripheral blood. Medium-sized form with solid protoplasm.

Fig. 6. Yaba. G.-p. 268. Peripheral blood. Ring form.

Fig. 7. Liverpool. G.-p. S II. Peripheral blood. Ring form.

Fig. 8. Liverpool. G.-p. G IV. Peripheral blood. Ring form.

Fig. 9. Liverpool. G.-p. S XXIII. Oblong ring form, almost rod-shaped.

Fig. 10. Liverpool. G.-p. S XXIII. Liver 'touch.' Initial 'blue body.'

Fig. 11. Liverpool. G.-p. S XXIII. Spleen 'touch.' Intra-corpuscular 'blue body.'

Fig. 12. Liverpool. G.-p. G I. Liver 'touch.' 'Blue body,' free.

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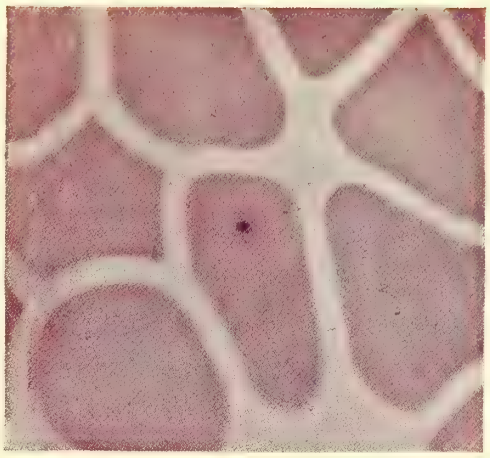

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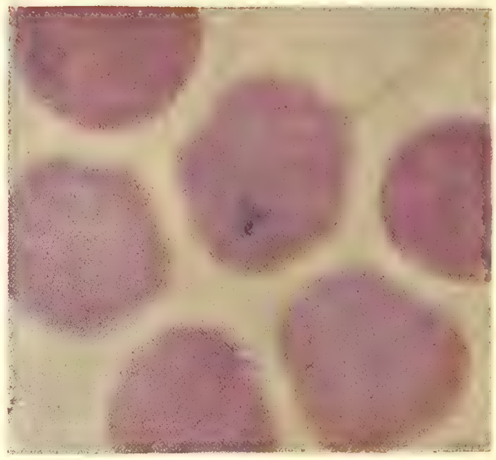

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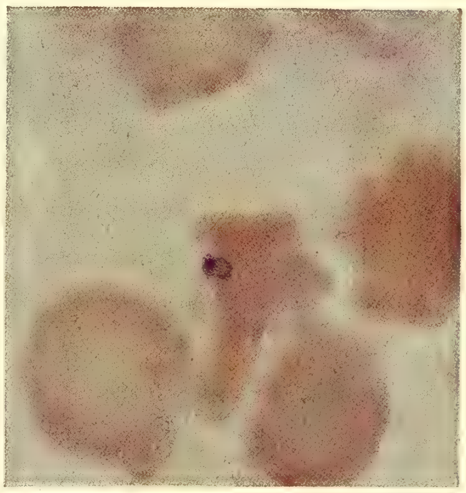

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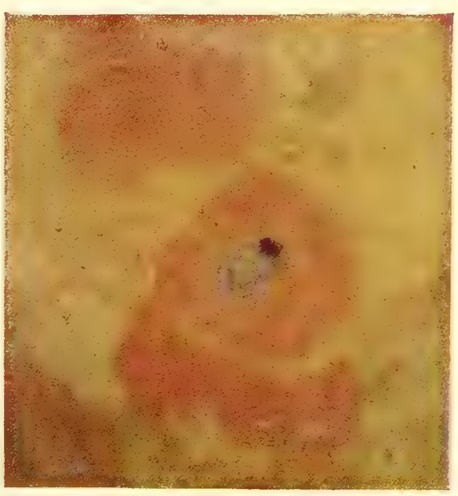

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12

REPORT ON SOME HISTOLOGICAL LESIONS OBSERVED IN LABORATORY ANIMALS INFECTED WITH YELLOW FEVER

BY

HARALD SEIDELIN, M.B. (Copenhagen), M.D. (Mexico), *Scientific Secretary, Yellow Fever Bureau, School of Tropical Medicine, University of Liverpool.*

A complete histological examination of the very large number of organs preserved from animals experimented upon at Yaba and in Liverpool would require years of continuous work. It is, however, at the present stage of the investigation, possible to form a general idea of the lesions prevailing in various important organs. The following remarks are founded upon the examination of organs from twenty-eight animals, twenty of which were observed at Yaba, one on board s.s. 'Falaba' and in Liverpool, and seven in Liverpool. The organs examined were, as a rule, lung, spleen, liver, and kidney, but in a few cases one or two of these organs had not been preserved; in several cases, other organs were also available for examination, but these are only briefly dealt with in this report.

The technique generally employed was fixation in Schaudinn's mixture of saturated mercury bichloride solution (2 pts.) and absolute alcohol (1 pt.), followed by embedding in paraffin. Thin sections were stained with Delafield's haematoxylin, Mayer's haemalum, ordinary or acid, or Seidelin's iron-haematein. Eosin or Hansen's aceto-picro-acid fuchsin solution was often used as a counterstain. Examination for fat was made by the freezing method and staining either with sudan III, scharlach R, or Nile blue sulphate. Iron-containing pigment was demonstrated by the Prussian blue reaction; to begin with Perls' or Schneider's technique was used, but later it was found that better results were obtained by treating the sections, after previous staining with paracarmin or alcoholic boraxcarmin, for about an hour with a weak solution (about 0·5 per cent.) of potassium ferrocyanide, prepared immediately before use and mixed with equal parts of 70 per cent. alcohol containing 1 per cent. of hydrochloric acid. Eppinger's method for the demonstration of the bile capillaries has been

applied in a few cases, and Best's glycogen stain also in a few cases; in these two methods celloidin embedding was used.

I shall first give the notes from several cases, as illustrations, and afterwards discuss the results obtained in these and in the total number of cases.

Guinea-pig 141, Yaba. Inoculated Oct. 15, 1913, with 0·7 c.c. of venous blood from yellow fever case L. 73; intraperitoneal injection. Dead Oct. 23. 8 *days*.

Post-mortem examination: No phenomena suggestive of yellow fever.

Histological examination.—Spleen: Diffuse hyperaemia. Marked erythrophagocytosis. Very numerous intensely pigmented cells in pulp and trabeculae; no pigmentation of Malpighian corpuscles.

Liver: Numerous patches of hyperaemia, in some places very intense. The protoplasm of the liver cells is as a rule of normal aspect, but the nuclei are often poorly stained. In some places the Kupffer cells are very prominent; many of these cells contain remains of erythrocytes, and others, or sometimes the same, contain yellow pigment. A few Kupffer cells contain fragments of nuclei, apparently resulting from the ingestion of polymorphonuclear leucocytes. In several lobules necrobiotic changes and leucocyte infiltration are seen; these phenomena are most marked in the middle zones.

Lungs: Moderate hyperaemia, showing a somewhat irregular distribution. Many alveoli are filled with fresh or more or less altered blood. In some places inflammatory phenomena occur: desquamation of bronchial epithelia, and perivascular and peribronchial infiltration.

Guinea-pig 153, Yaba. Inoculated Oct. 23, 1913, with 0·1 c.c. venous blood from guinea-pig 148; subcutaneous injection. Dead Oct. 27. 4 *days*.

Post-mortem examination: Congestion of *liver* and *stomach*. One ecchymosis in *gastric mucosa*. *Kidneys* also congested. *Spleen* and *lungs* appear perfectly normal.

Histological examination.—Spleen: Blood contents about normal. Marked erythrophagocytosis and moderate pigmentation of large cells in pulp and trabeculae.

Liver: In some places moderate to intense hyperaemia, the cell trabeculae being sometimes completely broken up by the haemorrhagic infiltration. The majority of the cells are well preserved, but a considerable number contain vacuoles or show various stages of necrobiotic changes. Many cells contain pyknotic nuclei. A small amount of fat is demonstrated by staining with sudan III.

Kidneys: The epithelial cells of a small number of tubules, convoluted or straight, contain minute fat granules (sudan III).

Guinea-pig 193, Yaba. Inoculated Nov. 18, 1913, with 0·2 c.c. venous blood from guinea-pig 192; subcutaneous injection. Dead Nov. 23. 5 *days*.

Post-mortem examination: Intense congestion and some enlargement of *liver*. Normal appearance of *spleen*. Slight congestion of kidneys. Faint albumen-reaction in *urine*. Four petechiae in *gastric mucosa*.

P. flavigenum found in heart blood, and in touch preparations from liver, lung, and bone-marrow.

Histological examination.—Spleen: A very large number of cells are filled, often to distension, with larger and smaller granules of a brilliant yellow colour, not staining with eosin. The same cells often contain erythrocytes or fragments of such; disintegrated erythrocytes are also seen in similar, but not pigmented cells. The phagocytes are mostly situated in the trabeculae, though also fairly

numerous in the reticulum of the pulp, but they are very seldom observed in the Malpighian corpuscles, and then only in their peripheral portions. The phagocytes are apparently endothelial cells. The blood contents of the organ seem about normal.

Liver : The structure is well preserved, and the blood filling is about normal. Some cells are vacuolated, and others show karyolysis or other necrobiotic phenomena. In places slight round cell infiltration.

Guinea-pig 210, Yaba. Inoculated Nov. 23, 1913, with 0·1 c.c. heart blood from the dead guinea-pig 193 ; intraperitoneal injection. Killed Nov. 29. 6 *days.*

Post-mortem examination : Slight hyperaemia of *liver*, *kidneys* and *gastric mucosa ;* no other organic lesions. The *urine* contains a large quantity of albumen.

P. flavigenum, ordinary forms, and blue bodies were found in touch preparations from spleen, liver, kidney, lung, and bone-marrow.

Histological examination.—Lung : Marked hyperaemia, slight exudation and desquamation. Several ' blue bodies ' observed in the sections.

Spleen : A considerable number of large cells contain more or less disintegrated erythrocytes, and a smaller number of cells contain granules or globules of yellow pigment ; sometimes both elements are observed in one and the same cell. These phagocytes are observed either in the trabeculae, apparently always in capillaries, or in the reticulum of the pulp, but are never seen in the Malpighian corpuscles. They are apparently endothelial cells.

Liver : Considerable hyperaemia, irregularly distributed in patches ; the arteries and veins of both systems are well filled, and the capillaries are often enormously distended. The bile capillaries appear moderately distended. The liver cells show more or less marked necrobiotic changes, the protoplasm being more or less vacuolated, and the nuclei showing karyorrhexis, or more often karyolysis. The cells of Kupffer are often necrobiotic. In some places there is slight leucocyte infiltration.

Kidney : Hyperaemia in irregular patches. Glomeruli normal. Cells of convoluted tubules granulated, sometimes disintegrating, sometimes vacuolated ; some karyolysis. Many convoluted and straight tubules contain granular masses (coagulated albuminous fluid) and sometimes cell débris ; other tubules are empty.

Guinea-pig 237, Yaba. Inoculated Dec. 8, 1913, by mosquito-bite. Killed Jan. 22, 1914. 46 *days.*

Post-mortem examination : No lesions observed macroscopically.

Histological examination.—Lungs : Moderate hyperaemia, slight inflammatory infiltration and desquamation.

Spleen : Marked erythrophagocytosis and very intense pigmentation.

Liver : Moderate vacuolation of hepatic cells and slight necrobiotic phenomena. Very marked pigmentation (haemosiderin) of Kupffer's cells and of endothelial cells in larger vessels.

In sudan-stained specimens many cells are seen to contain a few fat droplets, and a few cells contain a considerable amount of fat. On the whole, however, the quantity of fat does not correspond to the marked degree of vacuolation, and vacuolated cells are also occasionally seen in the sudan-stained sections.

Kidney : Small patches of hyperaemia are irregularly distributed throughout the sections. Some convoluted tubules contain granular débris.

Guinea-pig 306, Yaba. Inoculated Jan. 9, 1914, by mosquito-bite. Killed Jan. 14, 1914. 5 *days.*

Post-mortem examination : Two petechiae in *gastric mucosa.* Faint albumen reaction in *urine.*

P. flavigenum in heart blood and touch preparation from lung ; ' blue bodies ' in preparation from spleen.

Histological examination.—Spleen : Exceedingly intense erythrophagocytosis and pigmentation (haemosiderin).

Liver : Numerous patches of hyperaemia, often with infiltrating haemorrhages. Very marked focal necrosis and in some places slight microcellular infiltration. Slight vacuolation. Nearly all Kupffer's cells show diffuse iron reaction, and many of these cells, as well as many endothelial cells in the larger vessels, contain disintegrated erythrocytes or pigment particles (which sometimes give iron reaction, and sometimes not), or both.

Kidneys : Necrobiotic changes are marked, especially in the epithelial cells of the convoluted tubules. Many of these tubules and some Bowman's capsules contain granular débris.

Lungs : Moderate hyperaemia. Slight inflammatory phenomena. In some capillaries phenomena of erythrophagocytosis are observed.

Guinea-pig 307, Yaba. Inoculated Jan. 10, 1914, with 0·2 c.c. venous blood from guinea-pig 301 ; intraperitoneal injection. Killed Jan. 16. 6 *days.*

Post-mortem examination : Hyperaemia, petechiae, and erosions in the *stomach.* No other organic lesions. No urine in bladder. ' Blue bodies ' in touch preparations from lungs and spleen.

Histological examination.—Lung : Moderate hyperaemia, irregularly distributed ; in a few places beginning inflammatory infiltration.

Spleen : Very marked erythrophagocytosis and yellow pigmentation of large cells, as in guinea-pig 210.

Liver : Most liver cells contain vacuoles, the aspect being that of a fatty change, but no fat staining is obtained ; the cells are otherwise fairly well preserved, most nuclei staining normally. In some places marked hyperaemia. Many Kupffer's cells contain yellow pigment.

Kidney : No fat. Patches of intense hyperaemia ; some interstitial haemorrhages and in a few places haemorrhages into the tubuli. The cells are as a rule well preserved, but in some tubuli contorti the epithelia contain vacuoles and in others they are granular or even disintegrated ; most nuclei are well stained, but others are somewhat pale.

Monkey (*Cercopithecus mona*) 326, Yaba. Inoculated Jan. 16, 1914, with 0·3 c.c. heart blood from guinea-pig 307. Killed Feb. 4. 19 *days.*

Post-mortem examination : No pathological lesions. Operation wounds from lung resection (Jan. 29), and gastrotomy and partial splenectomy (Jan. 31) clean. No haemorrhages.

' Blue bodies ' in touch preparation from spleen.

Histological examination.—Spleen : Marked erythrophagocytosis and intense pigmentation (chiefly haemosiderin). Slight oedema of stroma.

Liver : A considerable number of liver cells show karyorrhexis and other necrobiotic phenomena. Slight vacuolation. Fat droplets are (by staining with sudan III) found in a few cells only. Many Kupffer's cells contain haemosiderin.

Kidneys : Patches of hyperaemia. Many Bowman's capsules and many convoluted tubules contain granular exudate. Some epithelial cells contain vacuoles. Slight oedema of stroma, especially perivascular.

Lungs : Slight hyperaemia and commencing inflammatory phenomena. Oedema of stroma.

Guinea-pig S II, Liverpool. Inoculated Feb. 28, 1914, with 0·2 c.c. heart blood from the dead guinea-pig 354. Dead April 8, 1914. 39 *days*.

Post-mortem examination: Ecchymoses of *pleurae;* congestion of *lungs; liver* slightly pale; *spleen* pale; *stomach* normal; intense albumen reaction in urine.

P. flavigenum in touch preparation from lung.

Histological examination.—Spleen: A considerable number of cells contain either disintegrated erythrocytes or yellow pigment, or both.

On the whole the tissue appears anaemic.

Liver: As a rule the blood-capillaries are distended and filled with blood, but some islets are seen which are completely anaemic. In some of these islets many cells are small, with granular, not reticular, protoplasm, and pyknotic nuclei; in other islets all the cells show more or less advanced necrobiotic phenomena, small cells with pyknotic nuclei appearing at the peripheral parts, sometimes together with a few polymorphonuclear leucocytes. In addition to these groups, isolated cells in necrobiosis are also seen in the hyperaemic areas and in those with normal blood supply. In most places, the bile capillaries appear narrow, but in some parts they are very wide, though apparently empty.

Kidney: Moderate diffuse hyperaemia, intense in patches; many convoluted tubules contain breaking-down cells, showing various degrees of karyorrhexis, and some tubuli contain débris. Most of the straight tubules contain large cells with clear protoplasm and well preserved nuclei.

Guinea-pig G IV, Liverpool. Inoculated April 9, 1914, with 0·2 c.c. heart blood from the dead guinea-pig S VI; intraperitoneal injection. Dead June 5. 57 *days*.

Post-mortem examination: Intense hyperaemia, irregularly distributed, of *lungs*. Several yellow patches in the *liver*. *Kidneys* slightly enlarged, congested, with minute haemorrhages and some yellow patches. A large haemorrhage on the surface of the left *testicle*. The *stomach* shows diffuse hyperaemia and numerous petechiae in the mucosa of the posterior wall and corresponding to the greater curvature, and one large haemorrhage on the anterior wall corresponding to the lesser curvature. Hyperaemia of *duodenum*. Spleen, pancreas, and suprarenals appear normal. No urine in bladder.

Histological examination.—Spleen: Blood contents about normal. Marked erythrophagocytosis and moderate pigmentation, of the usual type. Marked diffuse iron-reaction of the phagocytes' protoplasm.

Liver: Hyperaemia in patches. Marked vacuolation and necrobiotic phenomena, especially in the intermediate zones of the lobuli. Many of the vacuoles contain fat (sudan III, scharlach R, and Nile blue sulphate), but in others no fat reaction can be obtained. Both hepatic cells and Kupffer's cells contain a small amount of glycogen (Best's method), the latter apparently more so than the former.

Pancreas: The majority of the epithelial cells are well preserved, but amongst the acini of normal appearance others are observed which are broken up and consist of disintegrated or vacuolated cells, or of cells of considerably reduced size.

Lungs: Hyperaemia and commencing inflammatory phenomena.

Kidneys: Patches of hyperaemia are common and are often accompanied by minute interstitial haemorrhages. Most cells are well preserved, but in some of the convoluted tubules the epithelia are markedly disintegrated.

Suprarenal capsules: A considerable amount of yellow pigment (iron-reaction negative) is observed in large, probably endothelial, cells in capillaries in the central

portion of the organ, and also in a few epithelial cells at the central extremities of the trabeculae.

Testicle : The testicle referred to above shows necrosis of the parenchyma. On the surface, and infiltrating the tunica albuginea, blood coagula are seen, partly in organisation, and partly fresh.

Stomach : In various places well circumscribed areas of hyperaemia are seen, with enormous distension of the capillaries in the mucosa, and with infiltrating haemorrhages between the glands, in some places perforating the epithelial layer so as to reach the surface. There is also some inflammatory cell infiltration, and in some places necrosis of inflammatory products and of the adjacent glands.

Guinea-pig S XXXIX, Liverpool. Inoculated Sept. 12, with 0·1 c.c. venous blood from guinea-pig S XXXVI ; intraperitoneal injection. Dead Sept. 17. 5 *days*.

Post-mortem examination : The *lungs* show intense hyperaemia. The *liver* shows hyperaemia and some yellow patches. The *spleen* appears normal. The *kidneys* are of a pale greyish colour, but the blood vessels are distended. The *stomach* shows intense diffuse hyperaemia and numerous petechiae in the mucous membrane. The *urine* contains a considerable amount of albumen.

Histological examination.—Spleen : Marked hyperaemia and very marked erythrophagocytosis ; slight pigmentation. With potassium ferrocyanide and hydrochloric acid a very large number of cells, especially those containing phagocytosed red cells, show a diffuse blue staining of their protoplasm ; also many of the pigment particles give the iron-reaction, but others remain yellow.

Liver : Large patches of intense hyperaemia are seen in many places. Vacuolation and slight necrobiotic changes are common, and complete necrosis is seen corresponding to the yellow patches. This necrosis, when not complete, affects the central and intermediate zones, whilst a more or less narrow periportal zone remains approximately normal. Some microcellular infiltration is seen in the peripheral portions of the necrotic areas.

Pancreas : Only a small portion of the organ, adherent to the spleen, is examined. In this portion some acini are well preserved, but in others the cells are vacuolated or show more or less advanced necrobiotic changes.

Lungs : Intense hyperaemia with haemorrhages and slight inflammatory phenomena.

Kidneys : In some parts there is a more or less intense hyperaemia, irregularly distributed. The glomeruli are often hyperaemic, otherwise of normal appearance. Many cells, especially in the convoluted tubules, show necrobiotic changes ; the nuclei are often pyknotic. One epithelial cell in a convoluted tubule contains a nucleus in mitosis.

Inguinal lymph node : The tissue appears somewhat hyperaemic. Moderate erythrophagocytosis. There is a considerable number of eosinophil cells. The protoplasm of many large (endothelial) cells give a diffuse iron-reaction.

The total number of animals dealt with in this report is 28, as follows : 27 guinea-pigs, viz. :—Yaba 141, 8 days (analyses* nos. 438-441); 153, 4 days (anal. 502 and 503); 170, 11 days (anal. 640-3); 181, 2 months after the first inoculation and 9 days after the second (anal. 1776-9); 193, 5 days (anal. 820-5); 210, 6 days (anal. 898-903); 223, 7 days (anal. 962-5); 237, 46 days (anal.

* These numbers refer to the books of records.

2025-8); 251, 6 days (anal. 1168-1171); 262, 24 days (anal. 1692-5); 275, 14 days (anal. 1560-3); 298, 8 days (anal. 1652-5); 306, 5 days (anal. 1738-41); 307, 6 days (anal. 1879-82); 311, 16 days (anal. 2128-30); 331, 5 days (anal. 2119-22); 334, 5 days (anal. 2105-8); 335, 11 days (anal. 2227-30); C 4, about 2 months after the first and 22 days after the second inoculation (anal. 1799-1802); and 354 (inoculated on the way home), 7 days (anal. L 10-13); and Liverpool S I, 39 days (anal. L 41-44); S II, 39 days (anal. 48-51); G III, 20 days (anal. L 70-75); S V, 29 days (anal. L 81-83); G IV, 57 days (anal. L 108-115); S IX, 63 days (anal. L 157-162); and S XXXIX, 5 days (anal. L 345-350); and one monkey, Yaba 326, 19 days (anal. 2263-6). Three of these animals, guinea-pigs 237, 306, and 311, were infected by means of mosquito bites; in all other cases blood was injected either under the skin (Yaba 153, 170, 193, 262) or into the peritoneal cavity (all others), the blood having been drawn in one case from an arm vein of a yellow fever patient, in the other cases either from the cavernous sinus of a living animal or from the heart of a dead one. Further details concerning the experiments are given in the Report by Dr. Connal and myself (1915)*.

The histological lesions observed in these cases varied considerably, as did also the various organic lesions observed on naked-eye examination. They may, however, all be referred to certain types, and, thus, are essentially similar, with one exception perhaps, namely, the condition of the liver observed in the case of guinea-pig 262. This liver is described as follows:—

> Large areas of mottled yellowish and reddish colouring are seen in all lobes, occupying the greater bulk of the organ.
>
> Microscopical examination shows inflammatory infiltration, necrosis, and haemorrhages. No coccidia; no bacteria.

The first impression at the post-mortem examination was that this was a case of multiple abscesses, and it was thought possible that the cause of this infection might be the condition of the stomach, which presented an ulcerated surface of considerable size, covered by a dark brown clot, in addition to the usual hyperaemia and haemorrhages. The microscopical appearances were, however, more similar to those met with in acute yellow atrophy of the liver in the

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* *Vide* Experimental yellow fever in laboratory animals (pp. 427-478 *supra*).

human organism and in various animals. If this view is correct, then we must regard the liver affection observed in guinea-pig S XXXIX, and described above, as a connecting link between the condition in guinea-pig 262 and the necrobiotic changes observed in the majority of cases. On the other hand, it is of interest in this connection that liver abscess has been described as a complication in yellow fever in the human.

A liver affection similar to that in guinea-pig 262 was observed in one other case during the work at Yaba, but this case was not further examined.

I shall now briefly summarize the lesions observed in the organs which appeared most severely affected.

Lungs. A more or less marked hyperaemia was always present, accompanied by haemorrhages into the alveoli. Slight inflammatory phenomena, in the bronchi and in the peribronchial tissues, were observed in some cases. Some desquamation of the alveolar epithelia was usually seen in connection with the haemorrhages.

The distribution of the hyperaemia was usually irregular, though the inferior lobi were particularly affected; but in one or two cases a peculiar phenomenon was observed, namely, a hyperaemia which was practically limited to the central part of the lobus, the superficial portions being of almost normal appearance.

In several cases small or minute haemorrhages were seen in the visceral pleura.

In a few cases a careful examination of lung sections with high power lenses revealed the presence of well preserved elements which evidently were identical with the 'blue bodies' described in the Report by Connal and myself (1915). The chromatin in these stained fairly well with haemalum, but more deeply with iron-haematein.

Stomach. Histological examination was only made in a few cases, and no information was added to that obtained by direct observation.

Liver. Hyperaemia was common, and sometimes very marked, but it was not a constant phenomenon. When present, it was as a rule irregularly distributed. In a few cases the tissue was unquestionably anaemic. Small infiltrating haemorrhages were occasionally seen in connection with hyperaemia. The liver cells showed usually

more or less marked necrobiotic changes, both in the form of disintegration of the protoplasm, and in the form of karyolysis, karyorrhexis, and pyknosis. Only in one case, G III, did practically all the hepatic cells appear normal. Vacuolation of the cells was very common, and often very marked, and in some cases the presence of fat was demonstrated, but it was obvious that the quantity of fat did not even approximately correspond to the number and size of the vacuoles.

The endothelial cells both of larger vessels and of the blood capillaries (Kupffer's cells) were in several cases very prominent, enlarged and often free in the lumina of the vessels. In such cases they usually contained yellow pigment similar to that observed in the spleen.

In a few cases slight inflammatory phenomena were observed. The peculiar conditions met with in a few cases have been discussed above. 'Blue bodies' were seen in the capillaries in a few cases.

Kidneys. Hyperaemia of some type or other appears constant, as well as degenerative changes varying in degree and extension.

Spleen. A slight enlargement was observed in some cases, but in the majority of cases the spleen was apparently of normal size. Hyperaemia was not a typical phenomenon and, when present, was rarely very marked. In a few cases, examined at a late period after the inoculation, the spleen was markedly anaemic. The one striking phenomenon in the examination of this organ was the excessive destruction of red blood corpuscles. Various stages of this process were observed. In some cases, mostly of short duration, the presence of more or less disintegrated erythrocytes in the large phagocytes was the dominant feature; in other cases enormous quantities of pigment were seen in the same class of cells; whilst in others again erythrophagocytosis and pigmentation were about equally marked. The pigment was usually iron-containing, haemosiderin, but in certain cases no iron-reaction was obtained, or only part of the pigment gave this reaction. The phagocytes were either large mononuclear cells in the pulp or endothelial cells in the blood vessels and in the trabecular capillaries. The Malpighian corpuscles showed in most cases no trace of this affection, but in a few cases it is stated that pigmented cells were seen in the peripheral portions of these elements, and in one case (G.-p. S. V.) even in their interior.

The accompanying table shows the intensity of the erythrophagocytosis and pigmentation, as compared with the length of the period intervening between inoculation and death.

Other Organs. Lymphatic nodes, suprarenal capsules, pancreas, and myocardium were examined in a few cases. The epithelial cells of the *pancreas* showed regressive changes similar to those observed in yellow fever; no special examination was made for fat. No phenomena of any importance were observed in sections of the *suprarenal capsules*. In one case indications of erythrophagocytosis were seen in an inguinal *lymph nodule*. In one case very marked vacuolation and slight granular change were observed in the fibres of the *myocardium;* a few fibres contained fat droplets; there were patches of hyperaemia and some infiltrating haemorrhages.

In several cases there was a marked oedema of the connective tissues of the various organs examined.

The phenomena here described are interesting from more than one point of view. The histological examination revealed the existence of pathological changes in many cases where no definite lesions had been found on direct observation.

The liver and the kidneys were almost constantly affected, and the changes observed in these organs were not unlike those seen in yellow fever, though they were as a rule less marked. In fact, in many cases the appearance of the liver cells is strikingly similar to that of the necrobiotic cells in yellow fever livers. There is also some similarity in the distribution of these lesions which are, in some cases, markedly 'mid-zonal,' thus resembling the type which da Rocha-Lima (1912) regards as characteristic of yellow fever. A very considerable difference is, of course, the absence of marked fatty change, but this difference may possibly depend on secondary circumstances. It may be due, perhaps, to the comparative scarcity of fat in the tissues of guinea-pigs, as well as in their food. This explanation holds good, of course, only in the case that the fatty change in yellow fever is of the nature of an 'infiltration,' and not of a 'degeneration'; but that this is really so, has, I believe, been made more than probable by modern researches into the pathology of fat metabolism. The view here advanced is also in accordance with the conception of the yellow fever liver, that the fatty change

Spleen: Erythrophagocytosis and Pigmentation.

Number of days	4	5	6	7	8	9	11	13	18	19-20	21-30	31-50	51-80
I. Injection of blood—													
1. Yaba													
G.-p. 141	...	...	...	...	E ++ P +++	...	...	...	...	...	...	...	...
G.-p. 153	E ++ P +	...	...	...	...	...	...	...	...	...	...	...	...
G.-p. 170	...	...	...	...	...	...	E ++ P +++	...	...	...	...	...	...
G.-p. 181	...	...	...	...	...	E ++ P +++	...	...	...	...	...	...	...
G.-p. 193	...	E ++ P +++	...	...	...	...	...	...	...	...	...	...	...
G.-p. 210	...	...	E ++ P +	...	...	...	...	...	...	...	...	...	...
G.-p. 223	...	...	...	E ++ P +	...	...	...	...	...	...	...	...	...
G.-p. 251	...	...	E ++ P +++	...	...	...	...	...	...	...	...	...	...
G.-p. 262	...	...	...	...	...	...	...	...	...	...	E +++ P +++	...	...
G.-p. 275	...	...	...	...	...	...	...	E +++ P +++	...	...	...	...	...
G.-p. 298	...	...	...	...	E ++ P ++	...	...	...	...	...	...	...	...
G.-p. 307	...	...	E +++ P +++	...	...	...	...	...	...	...	...	...	...
Monkey 326 ...	...	...	...	...	...	...	...	...	...	E ++ P +++	...	...	...
G.-p. 331	...	E +++ P +++	...	...	...	...	...	...	...	...	...	...	...
G.-p. 334	...	E ++ P +++	...	...	...	...	...	...	...	...	...	...	...
G.-p. 335	...	...	...	...	...	...	E +++ P +++	...	...	...	...	...	...
G.-p. C 4	...	...	...	...	...	...	...	...	...	...	...	...	E + P +

SPLEEN : ERYTHROPHAGOCYTOSIS AND PIGMENTATION.—*continued*

Number of days	4	5	6	7	8	9	11	13	18	19-20	21-30	31-50	51-80
2. S.S. 'Falaba'													
G.-p. 354	...	...	...	E ++ P +++	...	...	...	...	...	...	...	...	...
3. Liverpool													
G.-p. S I ...	...	...	...	...	...	...	...	...	...	...	...	E ++ P ++	...
G.-p. S II ...	...	...	...	...	...	...	...	...	...	...	...	E + P +	...
G.-p. G III ...	...	...	...	...	...	...	...	...	...	E ++ P +++	...	...	...
G.-p. G IV ...	...	...	...	...	...	...	...	...	...	...	...	...	E ++ P +
G.-p. S V ...	...	...	...	...	...	...	...	...	...	...	E ++ P +++	...	...
G.-p. S IX ...	...	...	...	...	...	...	...	...	...	...	...	...	E +++ P +++
G.-p. S XXXIX	...	E +++ P +	...	...	...	...	...	...	...	...	...	...	...
II. Mosquito-transmission—													
Yaba													
G.-p. 237	...	...	...	...	...	...	...	...	...	...	...	E ++ P +++	...
G.-p. 306	...	E +++ P +++	...	...	...	...	...	...	...	...	...	...	...
G.-p. 311	...	...	...	...	...	...	...	...	E ++ P ++	...	...	...	...

is secondary to the necrobiotic changes, an opinion which has first been clearly formulated by da Rocha-Lima (1912).

The most interesting phenomenon from a general pathological point of view is the very marked erythrophagocytosis followed by pigment formation. This process was most marked in the spleen, but has also been observed in a lymphatic node and in the endothelial cells of the liver. The pigment gave as a rule iron-reaction and must be classified as haemosiderin; but in a number of cases iron-free pigment was also present, probably haematoidin which is identical with bilirubin. Whether the latter pigment is a modification of haemosiderin, is uncertain, but some support is given to this hypothesis by the observation that the protoplasm of cells which contained iron-free pigment often gave a diffuse iron-reaction. If this should be correct, then we might assume the existence of a close relationship between the pigmentation observed in these cases and the jaundice in yellow fever. There is, however, also a possibility that part of the pigment may be haemofuscin which, though iron-containing, does not give the usual iron-reactions. No marked reaction for bilirubin was obtained, but this may have been due to the small amount of iron-free pigment in comparison with the large quantity of haemosiderin. I shall, in this place, not go further into this question which I have taken up in connection with investigations on the pathogenesis of the jaundice in yellow fever. It appears probable that the observations here recorded may ultimately throw some light on this difficult problem. It may just be mentioned, for the sake of comparison, that a considerable number of investigations on the subject of 'haemolytic jaundice' have brought to light phenomena very similar to those here described. Thus, Minkowski and Naunyn (1886) describe the appearance in the liver capillaries of large cells containing erythrocytes, soon after poisoning with arsenic. M'Nee (1914), after poisoning dogs with toluylendiamin, found that the endothelial cells of the spleen contained erythrocytes and haemosiderin, but no bile; similar conditions were observed in the lymphatic nodes; in the bone marrow bile pigment was observed in one case, in addition to brown pigment and fragments of erythrocytes; the Kupffer cells in the liver contained disintegrating red cells and bile pigment, and their protoplasm gave a diffuse iron-reaction. Pearce and Austin (1912) observed that in

splenectomised dogs the lymphatic nodes and possibly the liver developed a compensatory function of erythrophagocytosis, which is also observed in these organs in certain pathological conditions concurring with an increase of this function on behalf of the spleen where it normally exists. Many other observations on the same and similar subjects are found in the literature, but must be reserved for discussion on another occasion.

There is no doubt that erythrophagocytosis and formation of pigment derivative of haemoglobin normally take place in the spleen, but according to my own experience added to that of previous writers such marked degrees as those here described are unquestionably pathological. After simple injection of blood, I have found in one case no increase of these phenomena, and in another case a marked increase of pigmentation, but none of the erythrophagocytosis. This result is not surprising, as the injected erythrocytes might be expected to become transformed into pigment, but not to give rise to phagocytosis of other red cells.

The pigment observed is evidently the same which Connal and I (1915) found in touch preparations from the spleen and believed to be bile pigment.

The demonstration of 'blue bodies' in sections of lung and liver is of interest from a parasitological point of view.

The accompanying plates illustrate the conditions described. Some further microphotographs were used to illustrate a communication read before the Pathological Society of Great Britain and Ireland (Seidelin, 1915). The two sets of photographs will to some extent supplement each other.

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EXPLANATION OF PLATES

All figures have been reproduced from photographs, the coloured figures either from autochromes (Lumière) (figs. 1, 10, 13, and 14) or colour photographs (Paget's duplicating method) (all other figures). Zeiss's apochromatic lenses and compensating eyepieces have been used throughout.

H means haematoxylin.
Ih ,, iron-haematein.
Ha ,, haem-alum.
Aha ,, acid haem-alum.
Bc ,, borax-carmin.
Pc ,, para-carmin.
E ,, eosin.
H ,, Hansen's aceto-picro-acid fuchsin solution.
S ,, modified Perl's method (iron-reaction).

Plate XI

Fig. 1. Stomach, g.-p. S XXXVI. Two comparatively large, and numerous minute, petechiae; marked diffuse hyperaemia. Natural size. Fixed in Kaiserling's fluid and mounted in gelatine.

Fig. 2. Stomach, g.-p. G IV. Section through petechiae. Intense hyperaemia, infiltrating haemorrhages, and slight inflammatory phenomena. Ih-H. Obj. 16 mm., oc. 8. × 170.

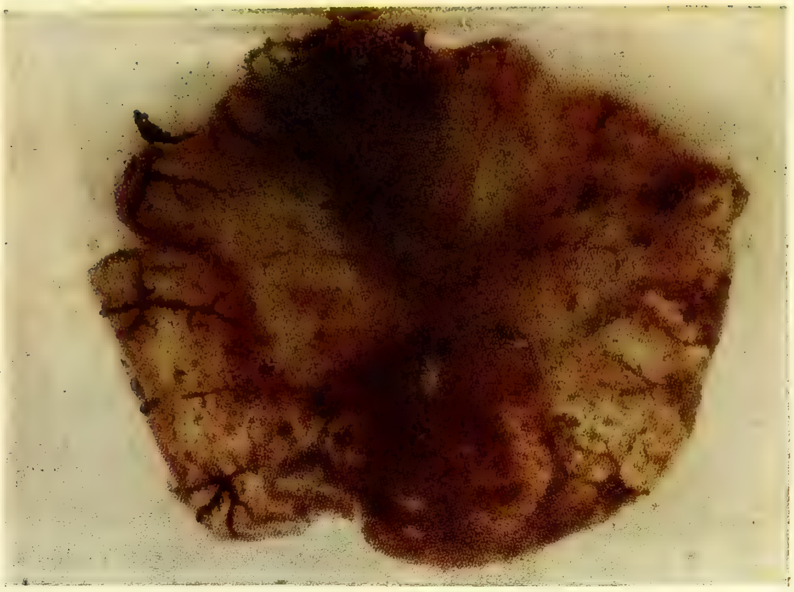


Fig. 1.

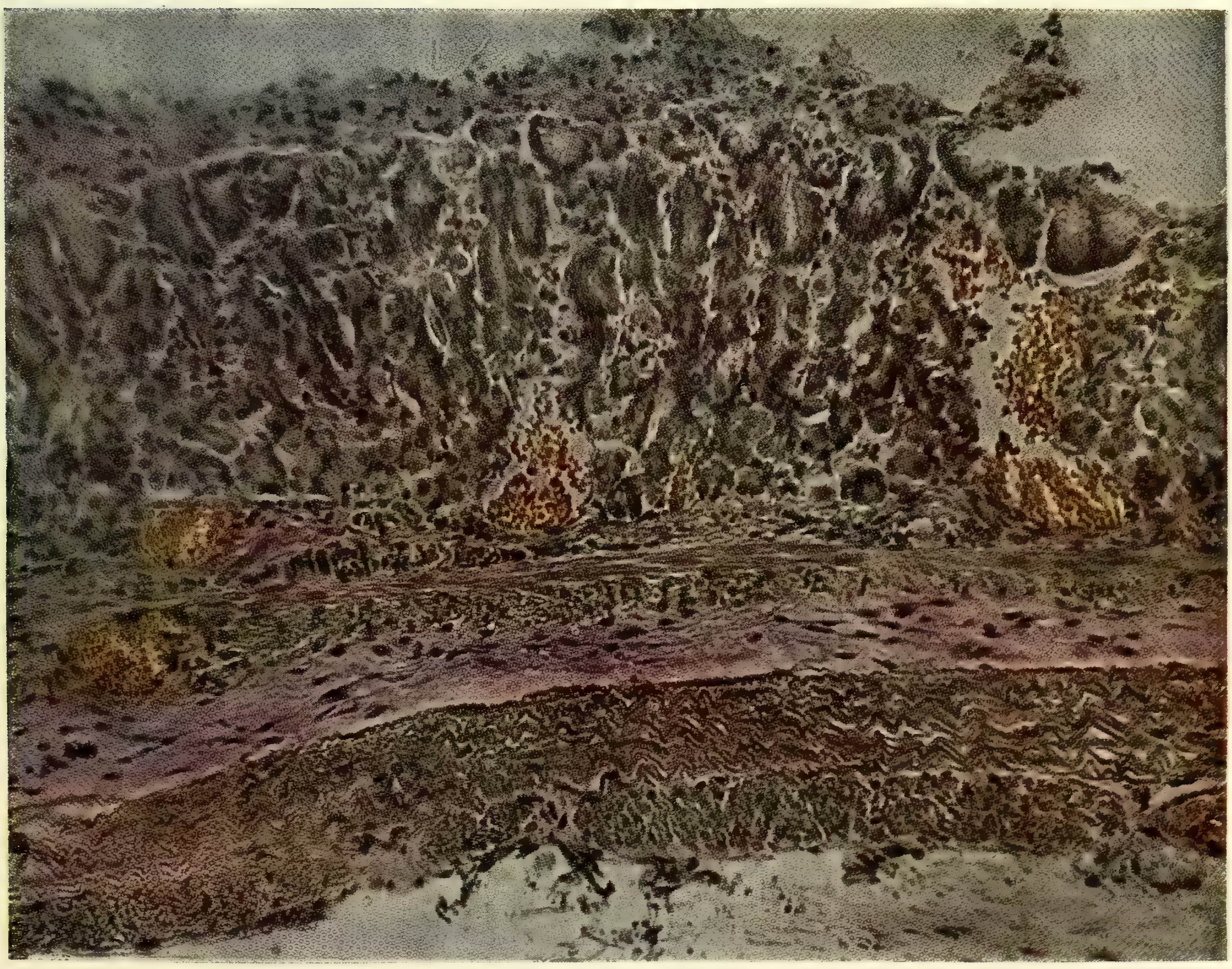


Fig. 2.

Plate XII

Fig. 3. Liver, g.-p. 298. Necrobiotic changes, 'mid-zonal type.' H-E. Obj. 16 mm., oc. 8. × 300.

Fig. 4. Liver, g.-p. 307. Vacuolation and slight necrobiotic changes, 'mid-zonal type.' H-E. Obj. 16 mm., oc. 8. × 280.

These two figures show that the 'middle zone' is situated much nearer to the hepatic vein (h) than to the v. portae (p). This corresponds to the type described by da Rocha-Lima as characteristic in yellow fever, whilst Opie's 'middle zone' in septic conditions affects the peripheral part of the lobulus more than the central portion.

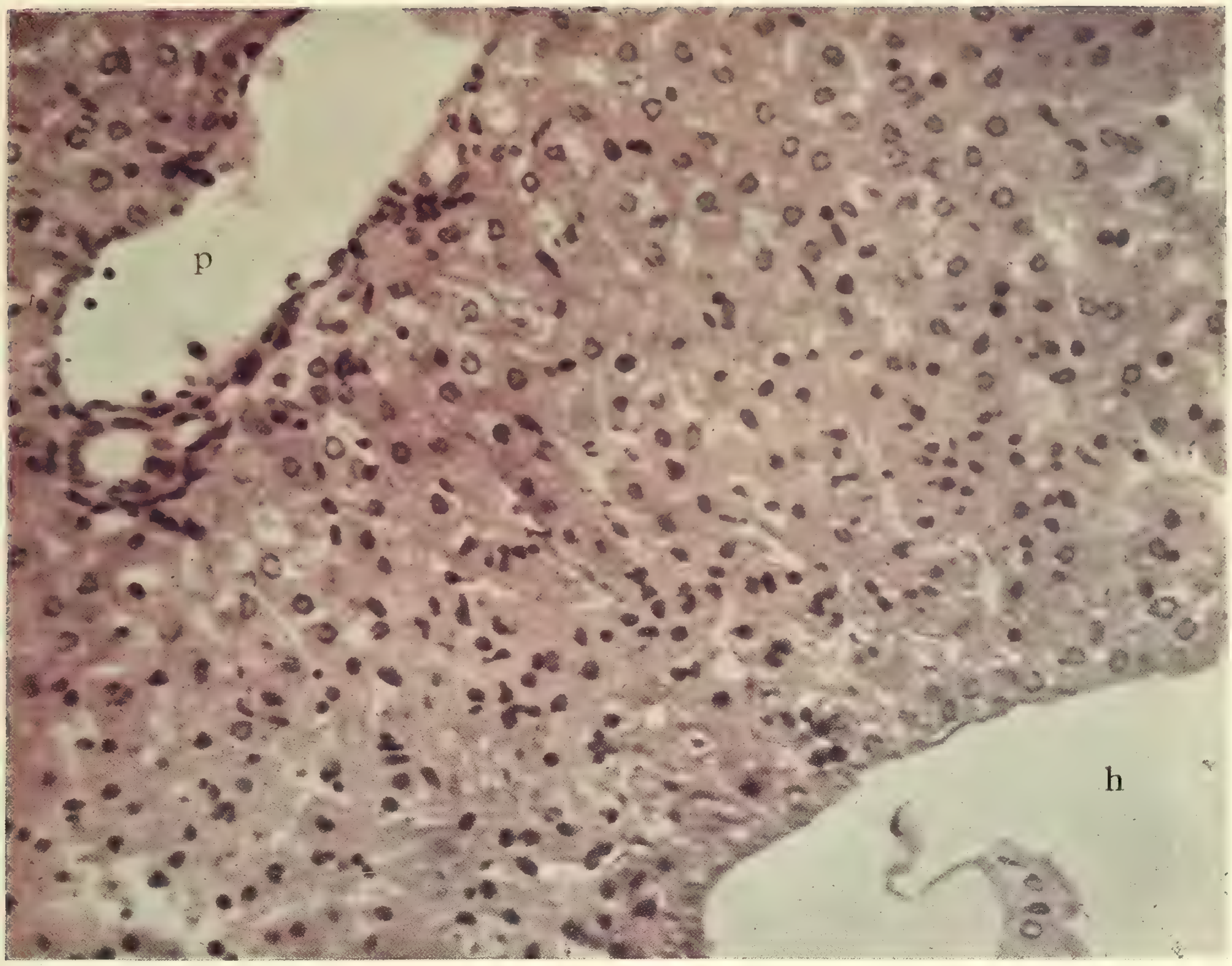


Fig. 3.

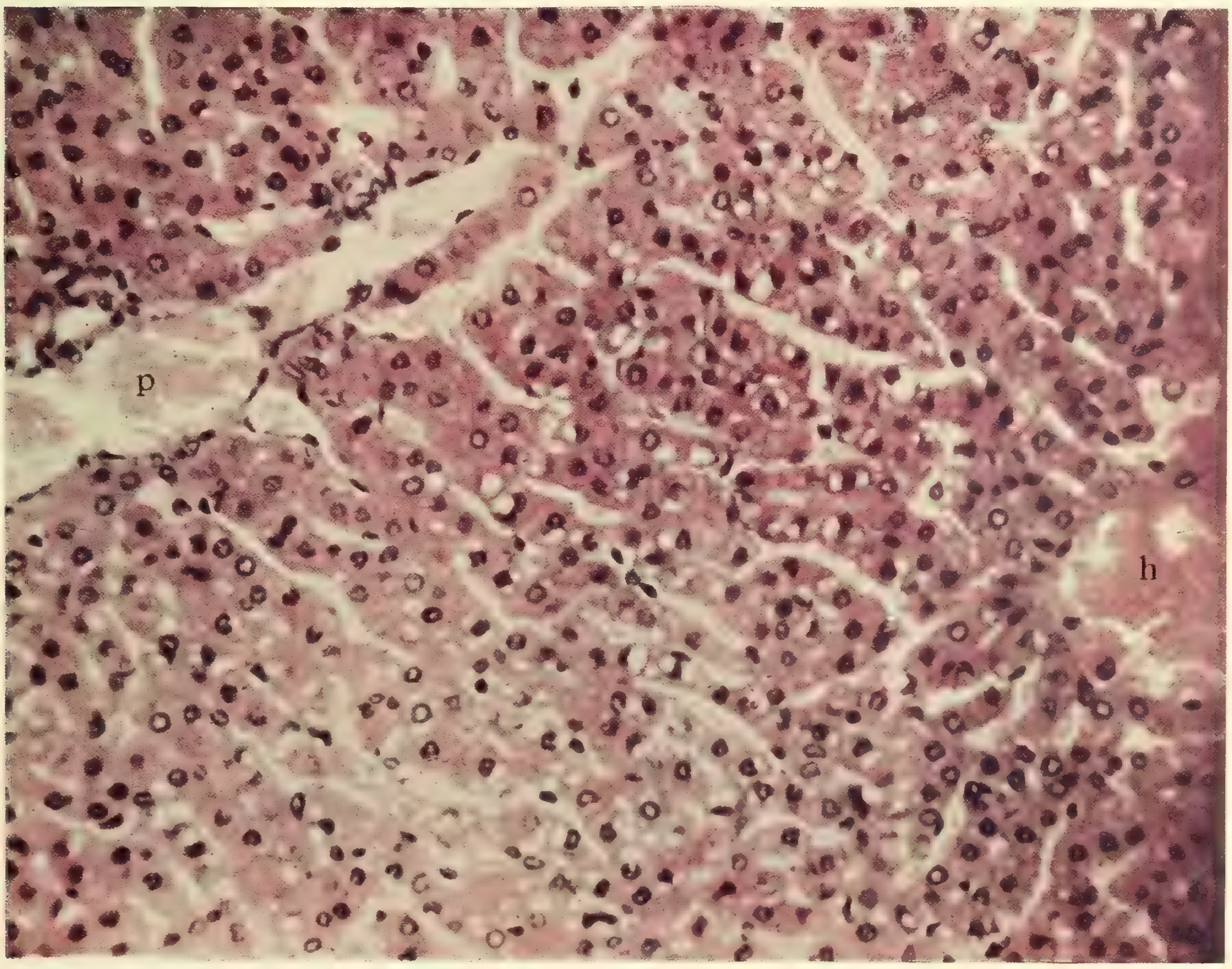


Fig. 4.

Plate XIII

Fig. 5. Liver, g.-p. S II. Intense hyperaemia. Ha-E. Obj. 3 mm. imm., oc. 4. × 560.

Fig. 6. Liver, g.-p. 306. Infiltrating haemorrhage. Aha-E. Obj. 3 mm. imm., oc. 4. × 460.

Fig. 7. Liver, g.-p. S I. Commencing necrosis. Ih-H. Obj. 3 mm. imm., oc. 8. × 640.

Fig. 8. Liver, g.-p. S XXXIX. Advanced necrosis, only a few liver cells close to the periportal tissues remaining more or less normal. Aha-E. Obj. 16 mm., oc. 4. × 82.

Fig. 9. Liver, g.-p. 153. Necrobiosis and vacuolation. H-E. Obj. 3 mm. imm., oc. 4. × 620.

Fig. 10. Liver, g.-p. G IV. Fatty change. Scharlach R and haematoxylin. Obj. 4 mm., oc. 4. × 450.

PLATE XIII.

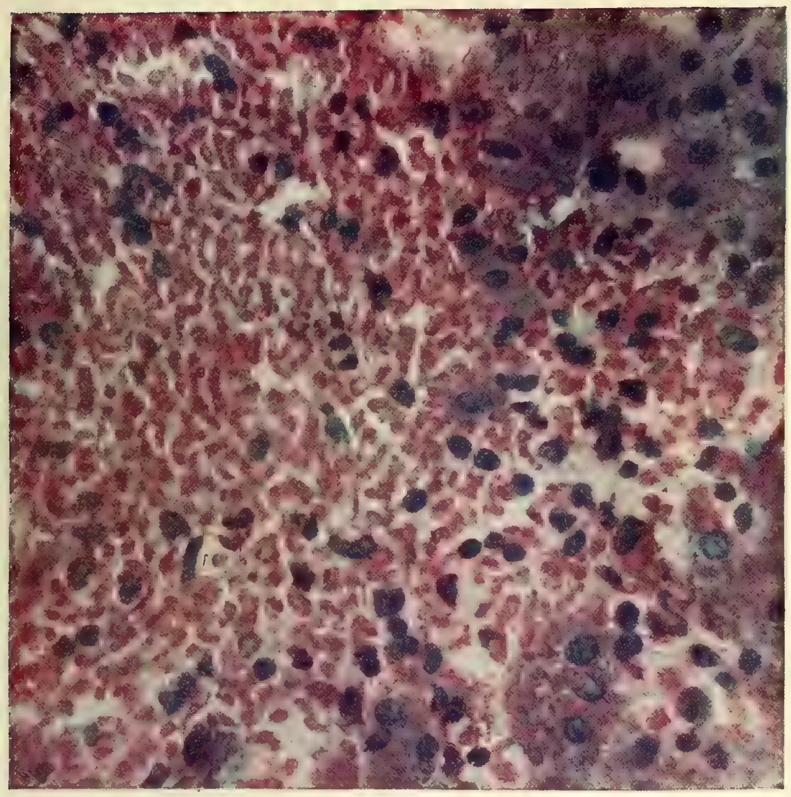


Fig. 5.

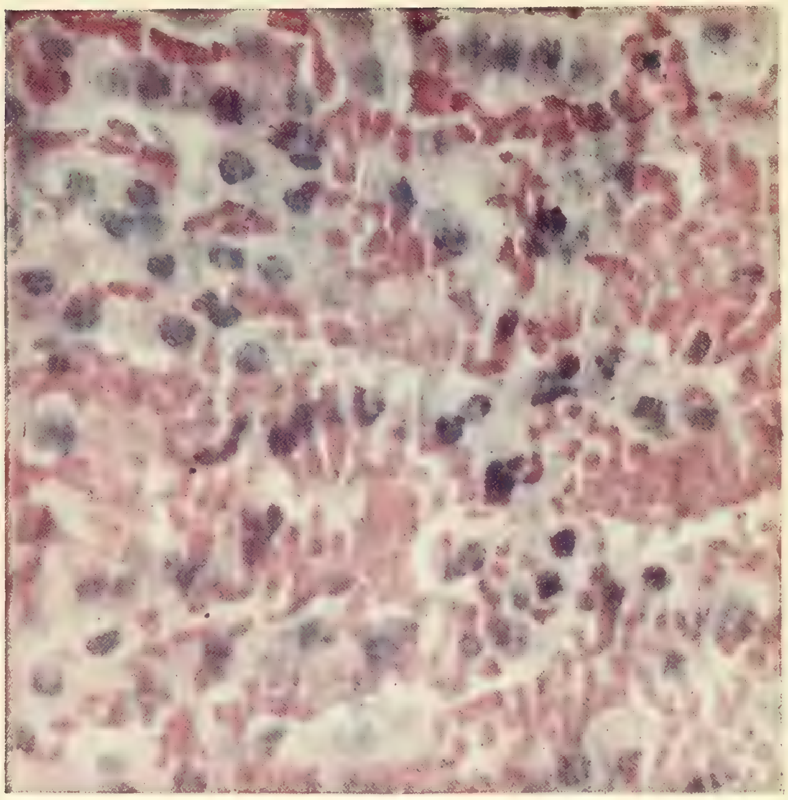


Fig. 6.

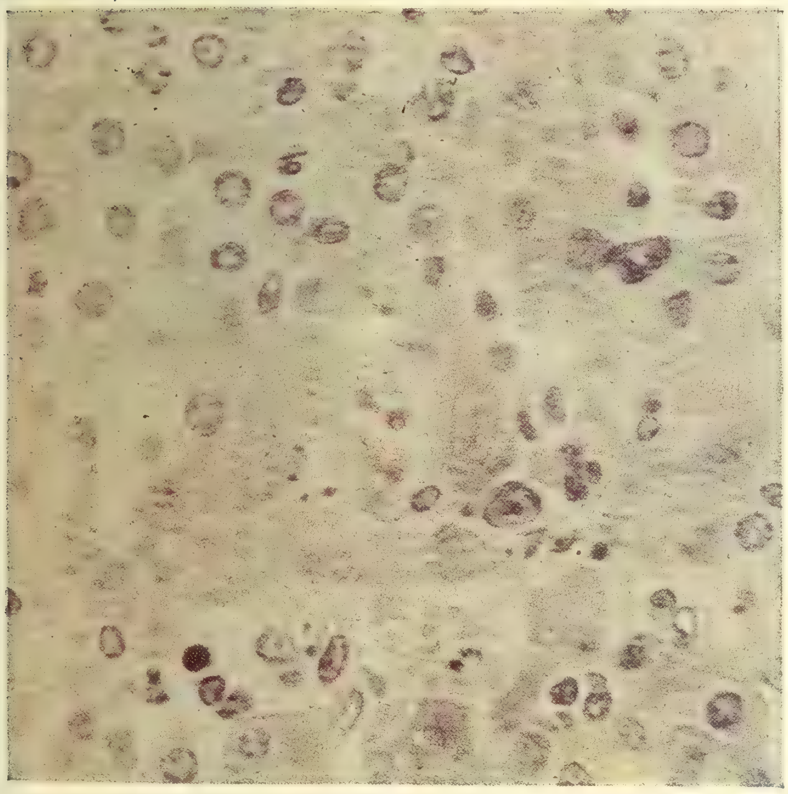


Fig. 7.

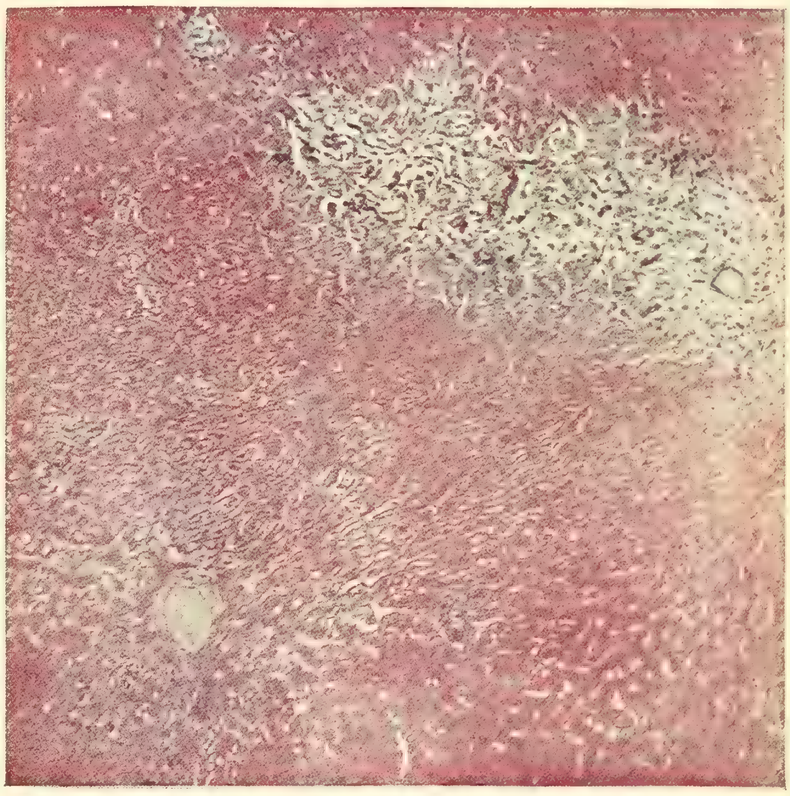
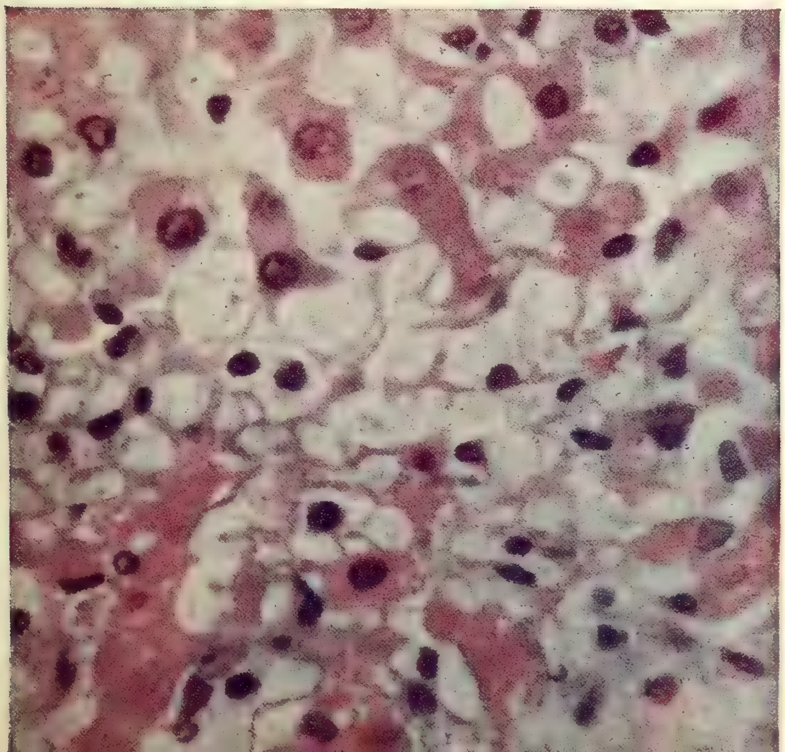


Fig. 8.



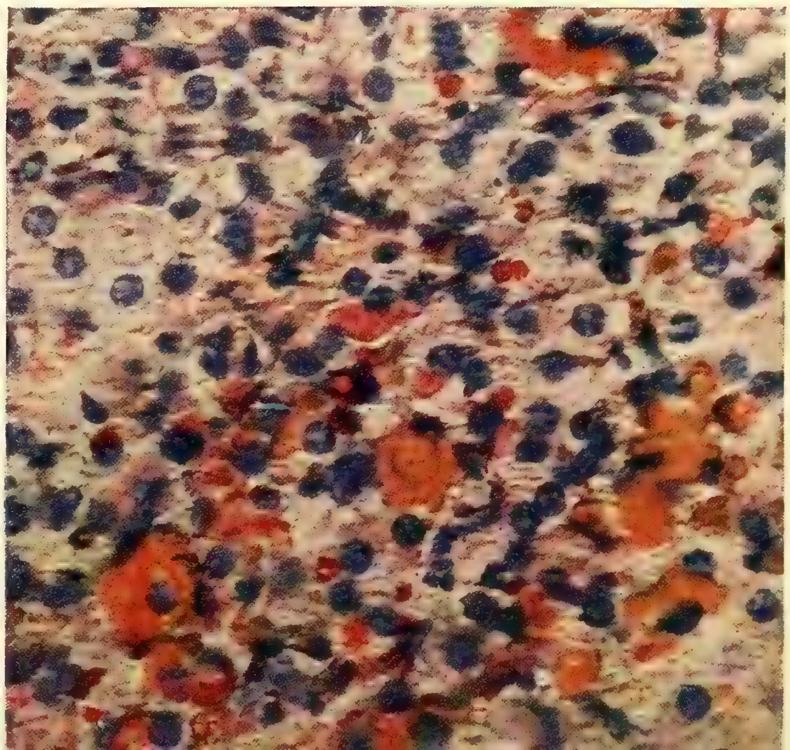


Plate XIV

Fig. 11. Spleen, g.-p. S V. Erythrophagocytosis and pigmentation. Aha-E. Obj. 3 mm. imm., oc. 8. × 720.

Fig. 12. Liver, g.-p. 298. Erythrophagocytosis and pigmentation of endothelial cells in large hepatic vein. H-E. Obj. 3 mm. imm., oc. 8. × 720.

Fig. 13. Spleen, g.-p. 306. Haemosiderin in cells; also diffuse iron-reaction in many cells. Bc-S. Obj. 3 mm. imm., oc. 4. × 380.

Fig. 14. Liver, g.-p. 237. Haemosiderin in Kupffer's cells. Bc-S. Obj. 3 mm. imm., oc. 8. × 630.

Fig. 15. Spleen, g.-p. S V. Macrophages; one containing a number of erythrocytes, several others containing large amounts of pigment. Aha-E. Obj. 3 mm. imm., oc. 8. × 1450.

Fig. 16. Spleen, monkey 326. Haemosiderin in macrophages. Pc-S. Obj. 3 mm. imm., oc. 8. × 720.

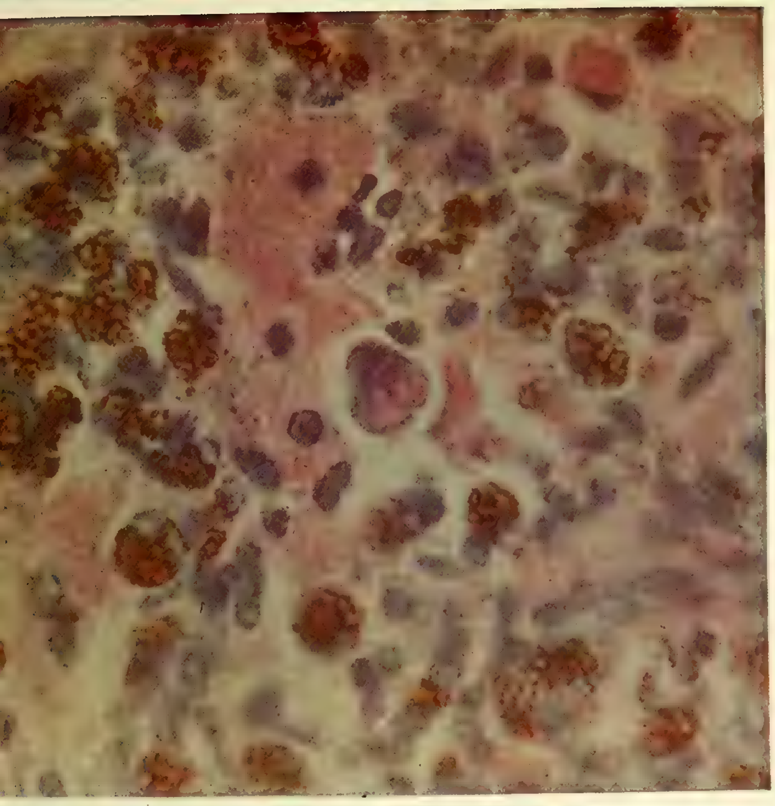


Fig. 11.

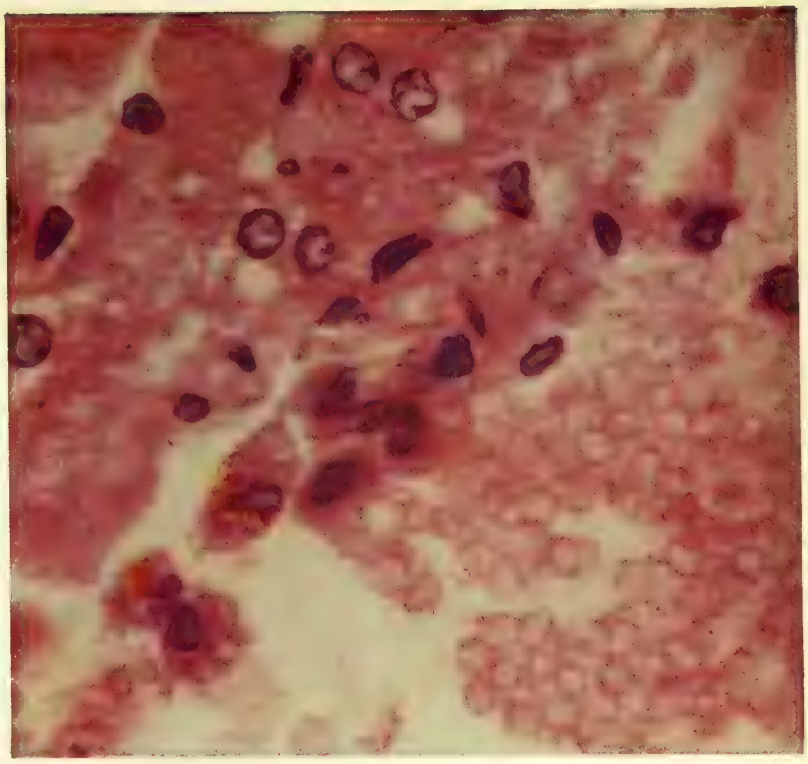


Fig. 12.

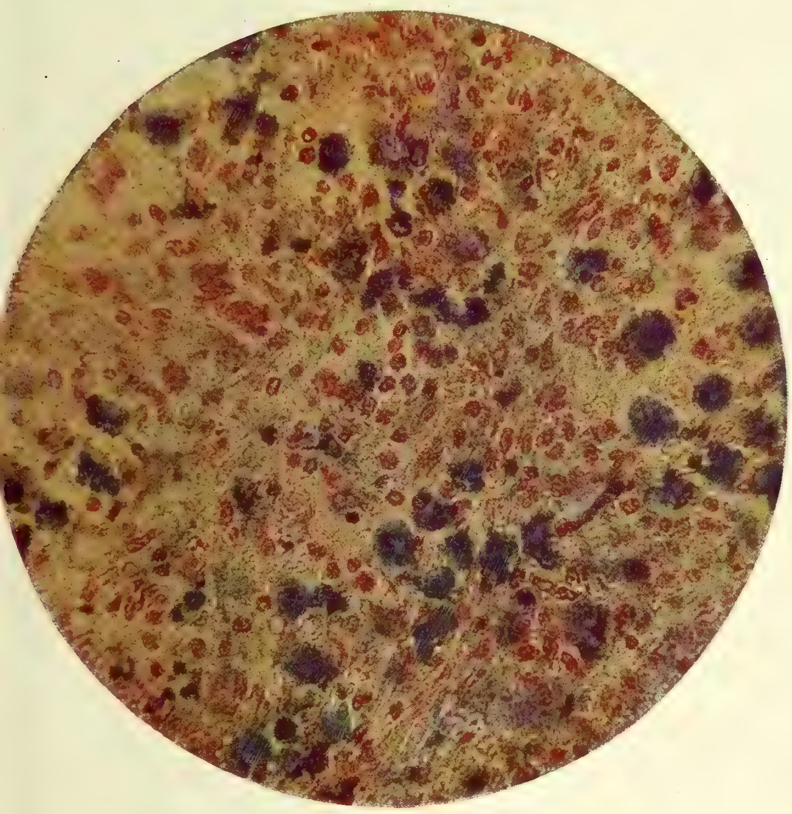


Fig. 13.

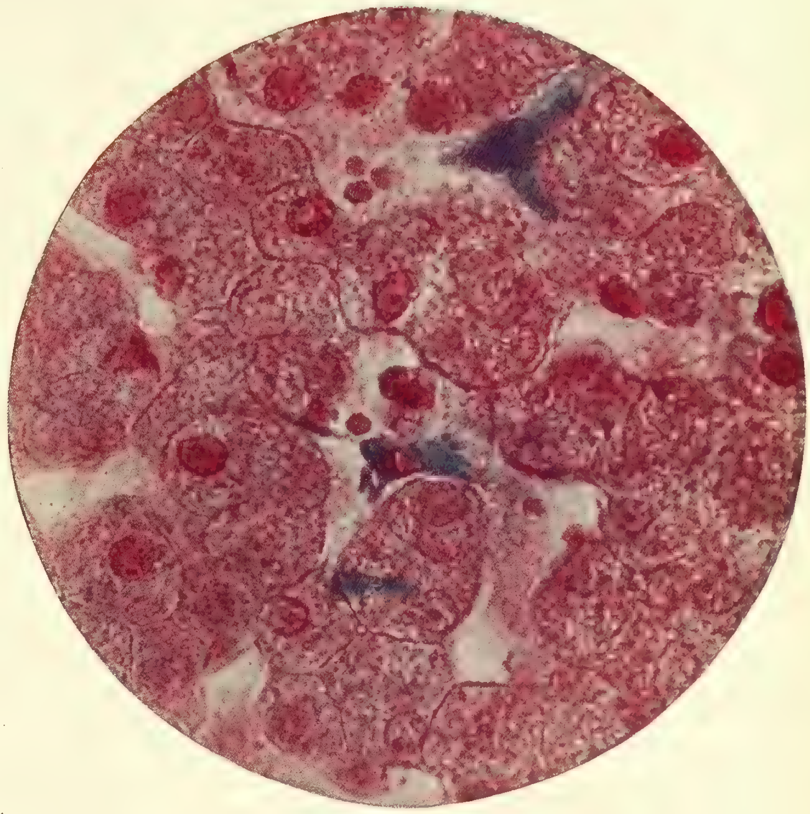


Fig. 14.

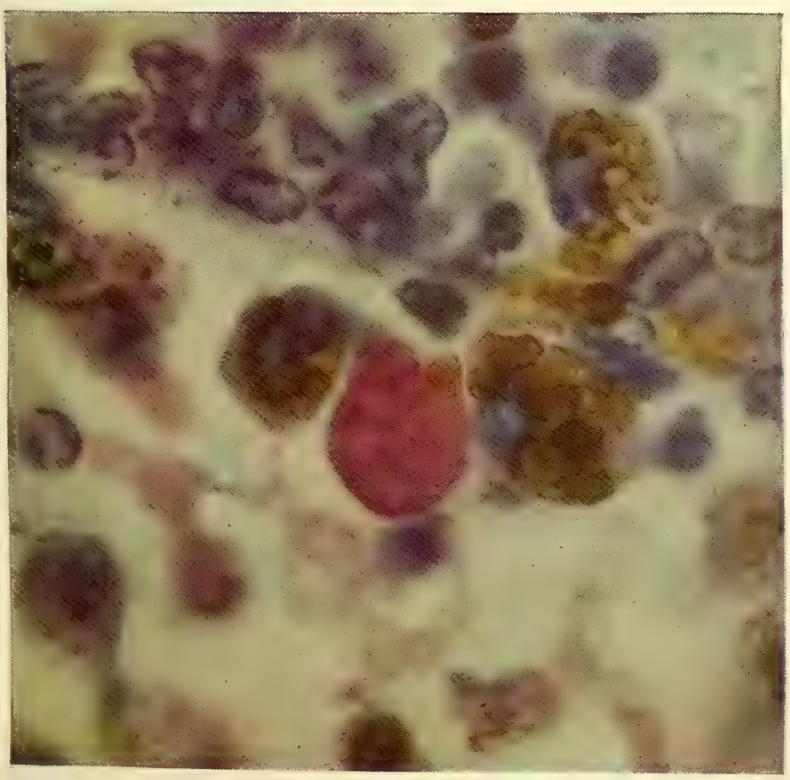


Fig. 15.

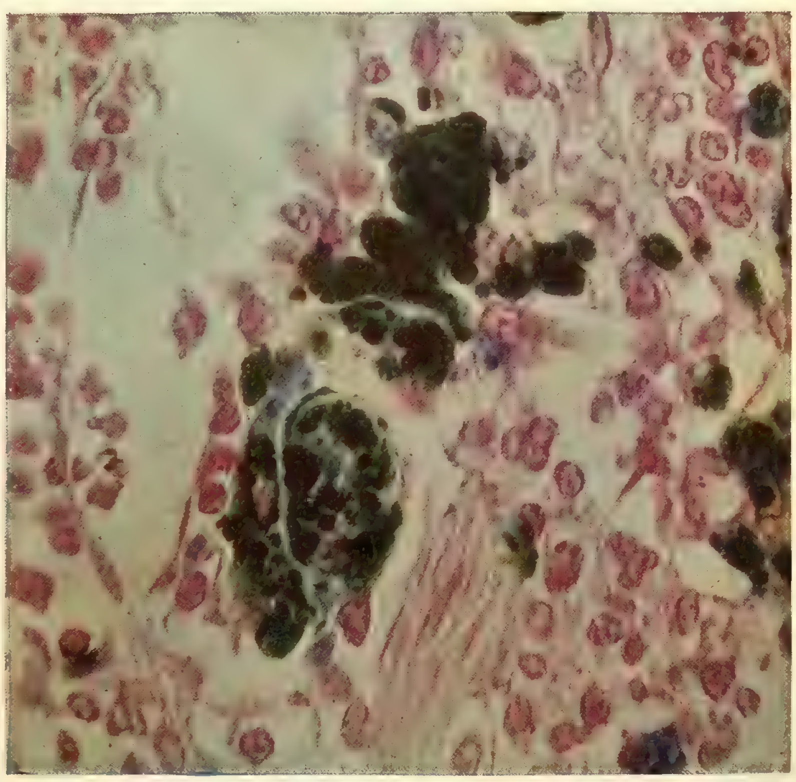


Plate XV.

Fig. 17. Pancreas, g.-p. S IX. Necrobiosis and vacuolation. Ha-E. Obj. 3 mm. imm., oc. 4. × 620.

Fig. 18. Myocardium, g.-p. S IX. Vacuolation. Ha-E. Obj. 3 mm. imm., oc. 4. × 620.

Fig. 19. Kidney, g.-p. 331. Hyperaemia, necrobiosis, débris in Bowman's capsules and in tubules. Ha-H. Obj. 16 mm., oc. 4. × 120.

Fig. 20. Kidney, g.-p. 210. One glomerulus hyperaemic, the other surrounded by granular exudate in Bowman's capsule. H-E. Obj. 3 mm. imm., oc. 4. × 425.

Fig. 21. Kidney, g.-p. S I. One straight tubule containing granular exudate (cast); another containing a group of desquamated cells; hyperaemia. Aha-E. Obj. 3 mm. imm., oc. 4. × 425.

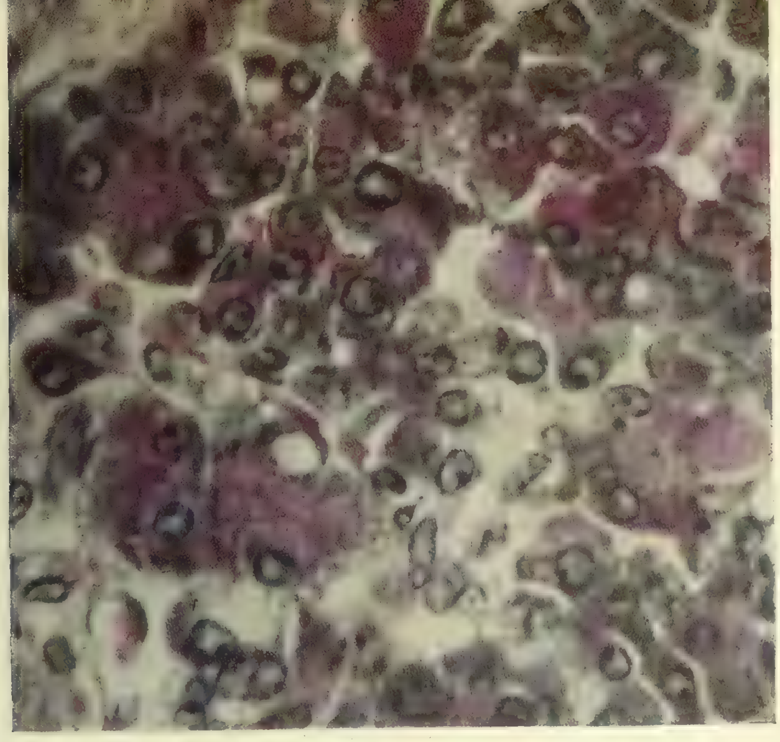


Fig. 17.

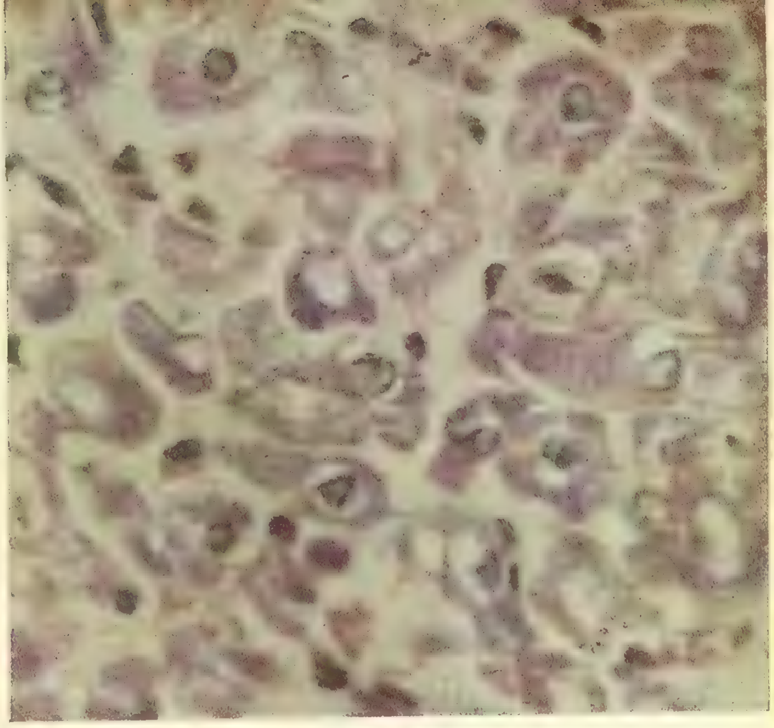


Fig. 18.

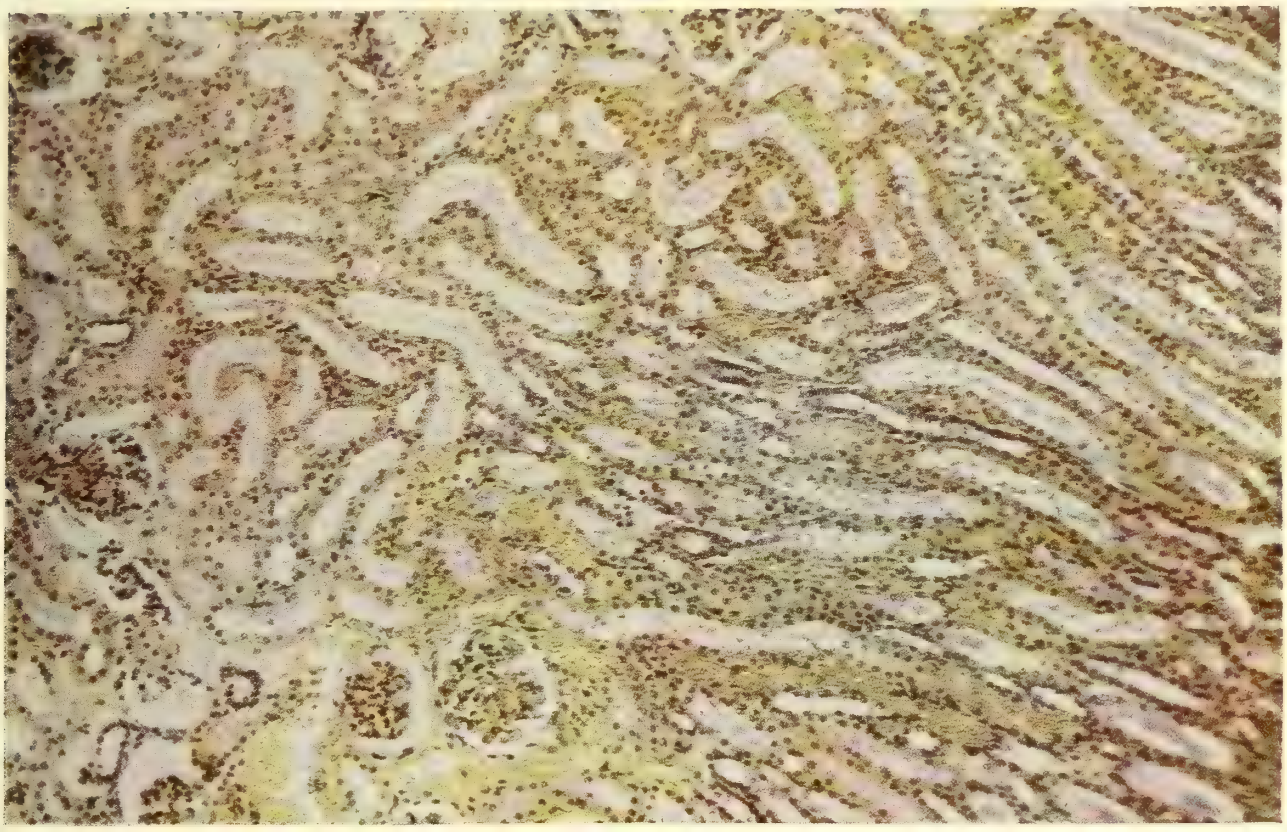
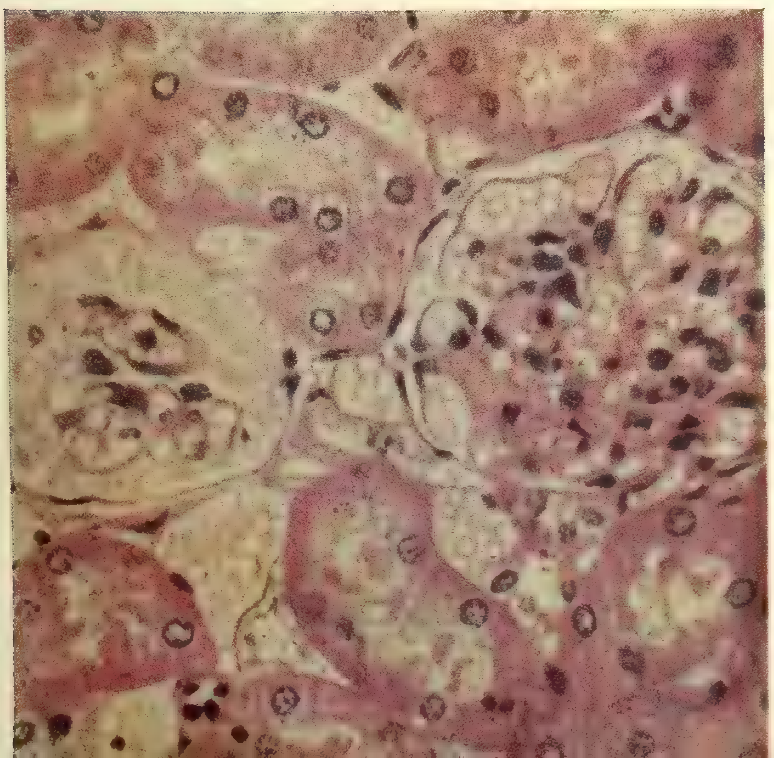


Fig. 19.



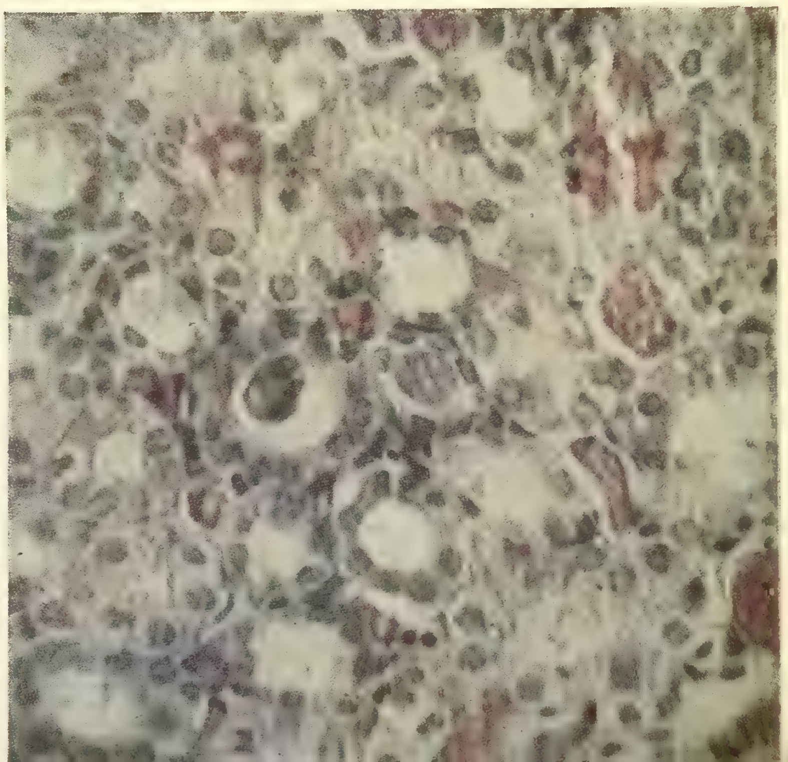


Plate XVI

Fig. 22. Lung, g.-p. 334. Intracorpuscular 'blue body.' Ih-H. Obj. 3 mm. imm., oc. 12. × 1750.

Fig. 23. Lung, g.-p. 210. 'Blue body.' Ha-E. Obj. 3 mm. imm., oc. 12. × 1750.

Fig. 24. Lung, g.-p. 210. 'Blue body.' Ha-E. Obj. 3 mm. imm., oc. 12. × 1800.

Fig. 25. Liver, g.-p. S IX. 'Blue body.' Ih-H. Obj. 3 mm. imm., oc. 12. × 1800.

Fig. 22.

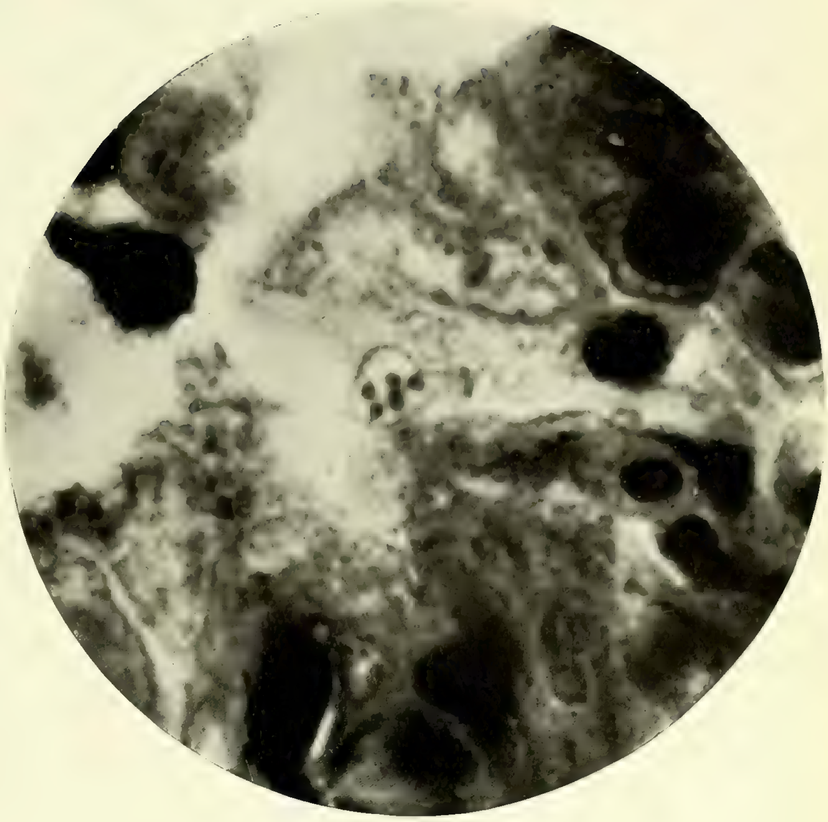


Fig. 23.

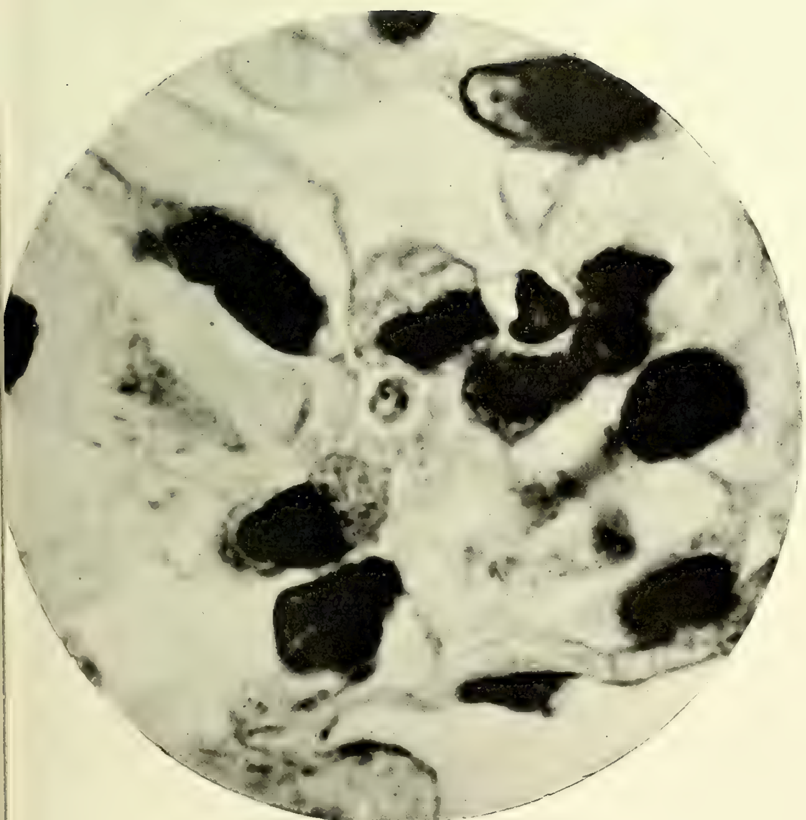


Fig. 24.

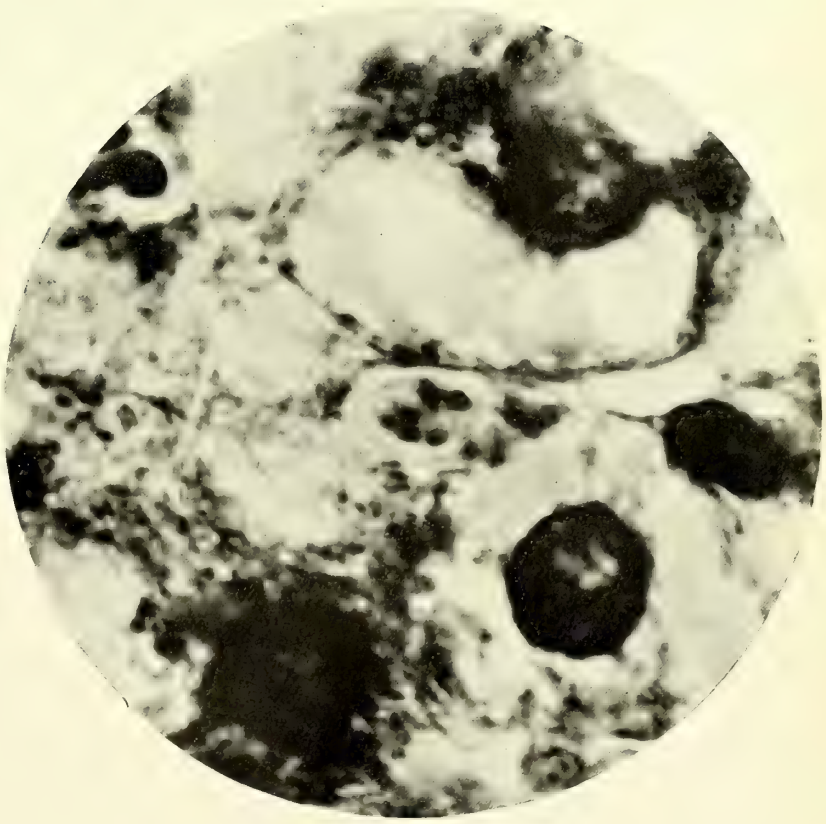


Fig. 25.

NOTES ON A VISIT TO SHERBRO DISTRICT *

BY

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It was hoped that as the sanitary state of Sherbro was believed to be favourable to domestic-breeding mosquitoes, the locality in general being low and swampy and the sanitary staff probably insufficient to cope with the conditions, cases of fever suitable for study might be readily found. A little investigation concentrated on a small and easily-worked area might be expected not only to yield clinical material of definite interest, but might be useful for comparison with the rather fruitless efforts in Freetown, where the sanitary organisation, besides effecting much real progress in many directions towards the public health, appears to have been largely successful in removing the carrier of yellow fever. We were influenced also by the fact that the Principal Medical Officer, who had recently visited Bonthe, brought to our notice the fact that for various reasons the sanitation was insufficiently dealt with, that refuse tins and bottles, etc., abounded, and that mosquitoes were numerous as compared with Freetown, and he recommended us to pay a visit and to examine the conditions of this locality, as being a likely place for fruitful work.

Leaving Freetown on the evening of Tuesday, January 27th, we reached Bonthe on Thursday, January 29th, and remained a fortnight, receiving quarters in the rest house, with the Medical Officer. The District Commissioner and other Europeans, heads of religious bodies, etc., rendered us at all times willing assistance.

The town of Bonthe faces N.E. The site is practically flat,

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* The Sherbro District lies on the coast of Sierra Leone, roughly speaking from 13° West longitude, for some eighty miles in a south-easterly direction. It consists chiefly of Sherbro Island, York Island, and Turner's Peninsula. Sherbro Island, the North-Western end of the District, lies in a large creek known as Sherbro River. The town of Bonthe (12° 30′ W., 7° 32′ N.) lies on its eastern side; Yonni is on the coast of the island, about 4½ miles S.S.W. of Bonthe: and York Island lies due East of Bonthe, about 2½ miles distant.

and is surrounded and intersected by mangrove swamps. At no place does the surface rise many feet above high water, and being largely submerged during the rains communication between different parts of the town and neighbourhood is effected by raised earthen roads, many of them of quite recent construction.

The population of Bonthe is composed roughly as follows:—40 Europeans, 30 Syrians, 5,000 natives (including liberated Africans, Mendi, Sherbro, and miscellaneous tribes).

The area of the settlement of Bonthe itself is about 205 acres, the whole southern boundary of which passes into mangrove swamp, while the frontage is interrupted by a depression branching backwards through the town into two brackish streams choked with vegetation. The latter, called Heddle Swamp, is, I believe, to be dealt with by an engineering scheme, but already partial filling in by private individuals has resulted in obstruction to the drains of other people's private houses.

The streets are fairly wide and well kept, except where they cross swampy streams, where grass grows up more quickly than it can be destroyed. Some eight and a half miles of streets have to be dealt with. Borrow-pits and hollows are numerous, and being now utilised as refuse holders in order to prevent their being interfered with and again opened up, show an amazing number of bottles, tins, etc. These, chiefly trade-gin bottles, exist in such numbers and accumulate daily (or perhaps nightly) in so many different places, that they may be said for the moment to constitute the chief trouble of the sanitary gang. As no rain has fallen for two months this potential danger happens to remain innocent for the present, no case of *Stegomyia*-breeding having been actually found in them; but attention is, of course, being directed to them in view of the approach of the rains, and recent energetic action by the District Commissioner, and the Medical Officer, with the sanitary staff, has already made an improvement.

The average rainfall for the preceding five years is 138 inches, but in 1913 only 106 inches fell. The months of December, January and February are generally rainless except for occasional slight showers. The water-supply consists partly of house tanks on all European quarters, with two large catchment tanks in the

town, which during the dry season are open at stated periods to the public; but mainly of private wells, which are very numerous and mostly provided with ill-fitting covers.

At the present season mosquitoes are not a pest—a few Europeans even dispense with the mosquito-net at this time of year—but one has no difficulty in observing a few every evening. During the rains everyone admits that they are abundant, but there is no record of the species found or of which are the most prevalent. Small domestic receptacles being so abundant and carelessly disposed of, one naturally suspects the *Stegomyia* to be predominant, and this is vouched for by previous Medical Officers who have worked in Bonthe. Our search in the present month of February, however has not revealed a single specimen of *Stegomyia*.

As there are several religious orders with mission schools, it was suspected that clinical material would not be difficult to find, and I went in person to the head of each mission school and was readily accorded an appointment at a selected time to examine the children. In addition, the pastor or schoolmaster in each case undertook to find out the cause of absence of each child temporarily kept at home, thus giving us an opportunity to examine any febrile case, but here again the results were—happily for the children—disappointing for us.

The examination of children in the schools was performed in conjunction with the Medical Officer, and the splenic index for ages under ten or twelve was recorded. In the four schools, the total number of children palpated was 236, and they showed a splenic index of 54 per cent. One or two cases of fever were detected in the course of this inspection.

1. Roman Catholic School. The Rev. Father Noirgean personally visited the homes of children of Roman Catholic families throughout the town, but reported that he could find no case of fever. Seventy-five children were examined in the school.

2. Church Missionary Society. The Rev. J. Williams made personal enquiries in conjunction with the headmaster. Three children absent on account of illness were reported, but they proved to be all trivial surgical cases. No cases of fever were discovered. Fifty-nine children were examined in the school.

3. United Brethren: Pastor Sumner. No children were

reported absent on account of illness, and no case was detected amongst the thirty-four examined in school.

4. Wesleyan Methodist School: Mr. J. C. Smith. Three children reported absent the previous day on account of illness; these were all present at the time of spleen palpation, and were examined, as they were noticed to be feverish. Two of them proved to have quartan malaria, and the third was suffering from indisposition, probably attributable to intestinal worms (eosinophilia, 21 per cent.).

The clinical cases which came before us for blood examination, either from the schools or at the native hospital, were very few in number, and were in general of the same nature as those which we are accustomed to see in Freetown. The proportion of malaria is possibly greater in Bonthe (for the time of year), but the number of our cases studied here is too small for comparison:—

Quartan malaria	4
Subtertian malaria	3
Helminthiasis	2
Hepatitis	1
Specific parotitis	1
Trivial case	1
	12

Turning now to the search for mosquitoes and larvae in Bonthe, the chief fact to record is the apparent absence at the present season of *Stegomyia*. One cannot, however, lay stress on this, and we may point to a similar absence of Anophelines, although there is no lack of enlarged spleens, and malaria parasites were readily found in a considerable proportion of the blood examinations. Both types are probably abundant in Bonthe during the rains, but there is no record of a mosquito survey, and one cannot therefore tell which are actually the prevalent species.

A complete house-to-house inspection of the whole town was not made, but each day a number of compounds and lots were gone over in all the different quarters, and thus a total of 82 came under examination. Mosquito larvae were found five times—once in a surface well or uncovered water-hole which had fallen into disuse, twice in shallow wells with ill-fitting covers, once in a water-barrel, and once in domestic utensils (one bottle, and one earthen jar).

All the larvae found were other than *Stegomyia.* These figures give a larva index of 6 per cent. (wells being included). The available figures for the larva index taken on previous occasions are given below, but it is to be noted that the earlier figures at least exclude wells:—

LARVA INDEX

		Bonthe		York Island
March, 1911	... ...	12 %	...	—
May, 1911 ...	... ...	11·8 %	...	3·3 %
August, 1912	... ...	7 %	...	—
December, 1912	... ...	5 %	...	—
March, 1913 (quarter)	...	0 %	...	0 %
June, 1913 ,,	...	3 %	...	2 %

No figures are given for the larva index during the rains subsequent to June, 1913, but the sanitary gang appear to have become slack in their duties and lacked close supervision. The number of summonses for all breaches of sanitary laws fell suddenly from 40 in July to 6 in August and zero in September and October, so that it is more than probable that domestic mosquitoes again multiplied, and all residents admit that they were very numerous a few months ago.

As stated above, our search failed to reveal a single *Stegomyia* larva, yet on looking over past sanitary reports we are confronted with the following, which is also a dry season record. On May 1st, 1911, Dr. Burrows, Medical Officer of Health, Sherbro, reported on a '*Stegomyia* census' of 105 houses (75 in Bonthe and 30 in York Island). The resulting figures were:—

Percentage of 'Larvae Houses' in Bonthe = 11·8
,, ,, ,, York Island = 3·3

The larvae found were stated in every case to be *Stegomyia*, and in one case mixed with *Anopheles* larvae. The prevailing weather was dry, but Dr. Burrows remarks, 'An increase of 75 per cent. might safely be anticipated during the rains, as I found *Stegomyia* larvae (which bred true) in every house I inspected in Bonthe in August last year (1910).' In the following year, in the height of the rains (August, 1912), Dr. Orpen recorded a larva index of only 7 per cent., and in his report comments on the unexpected difference between this figure and that predicted above. His house-to-house

inspection was very carefully and completely worked out, and he suggests as possible explanations of the reduction of larvae to such a low figure in the wet season, the following:—

(1) Heavy rainfall (36·6 inches) during the said month, perhaps 'flushing and keeping flushed the various articles capable of holding water.'

(2) A vigorous campaign during the previous week against dirty compounds, resulting in a series of summonses.

(3) The vigilance of the occupants (as a result of the sanitary campaign and its penalties), who immediately bustle about and empty every tub, barrel, pot, etc., leaving the yard still wet, when the cry 'Doctor do come' is raised.

It is probable that the second of the above suggestions holds the key to the solution, and that in Bonthe, as in Freetown and everywhere else, the strict enforcement of regulations for domestic sanitation and a well-maintained supervision are essential, and are generally effective in reducing domestic-breeding mosquitoes to a proportion which probably ceases to be dangerous.

It may be added that in Sherbro, as in Freetown and elsewhere in Sierra Leone, a common hedge plant is a variety of Dracaena, which retains water in the axils of the leaves. In Freetown a few months ago *Stegomyia* larvae were found in this situation in many compound fences, and in Bonthe the plant has been proved to be a prolific source of mosquitoes during the rains.

In regard to adult mosquitoes, the chief and almost the only sheltering places for these were holes in the ground, such as crab-holes, toad-holes, holes at the roots of trees or in broken fences where a stump had been pulled out. The search being generally made in the morning, adult mosquitoes were only rarely caught inside the houses, but practically always in holes such as those described. Crab-holes, etc., at a little distance from a house rarely if ever harboured mosquitoes, and never if lying in direct sunlight, but within the compound, and especially when situated around the mud base of the house, disturbance of these holes rarely failed to dislodge the insects, in some cases in considerable numbers (in one compound, indeed, their exit from every hole might be described as in clouds). Many of the houses built and occupied by Sherbro natives have a low buttress of solid mud around the base, and

beautifully kept, well swept yards, in which holes of any sort could not be detected.

The commonest mosquito found in such places was *Uranotaenia annulata*,* but *Culex insignis* was also abundant, then *Culex decens*,* *Culiciomyia* (*sp.* ? *freetownensis*),* and *Culiciomyia* (? *nebulosa*) in the order named. Specimens also of *Ochlerotatus* (2) *sp.* (? *nigrocephalus** and ? *caliginosus*), *Mansonioides uniformis*, *Culex tigripes*,* and *Taeniorhynchus annettii* were caught. The breeding places may be said to have been only partially determined, but one or more imagines of five of the species mentioned (indicated by an asterisk) were ultimately hatched out from larvae put aside on the five occasions when these were discovered. The total number of larvae found is insignificant compared with the abundance of adults of some of the species.

No specimen of *Stegomyia* or of any Anopheline species was found, either adult or larva, in any compound. A single larva of *Anopheles* (*Myzomyia*) *funesta*, however, was found along with *Cyclops*, etc., in a fairly clean marshy area containing water lilies on the outskirts of the town. *Uranotaenia* and *Culex insignis* greatly outnumbered all the others, yet only once was the former hatched from larvae found in a well, and *Culex insignis* not at all. It is possible that these mosquitoes are hibernating, and breeding but little in the present season.

A single specimen of *Phlebotomus duboscqii* was caught. A previous Medical Officer (Dr. Orpen) states that during his time in Bonthe these were numerous.

A list of mosquitoes and other blood-sucking flies caught during our visit and determined by Dr. Johnson is appended.

York Island

Two visits were made to York Island, which acts as the port for Sherbro, and consists of a smaller settlement on another reach of the branching creeks. Two European firms with eight or ten employees, and a native town of about 1,200 people compose the population. The inhabited portion is a flat area of mud, surrounded, and in part intersected, by muddy mangrove swamps, empty, except in pools, during low tide. The average difference

between high and low tide is about five to eight feet; the highest natural point of land surface is not much more than four feet above high water, and natural surface drainage is almost nil. The distance from Bonthe is about two or three miles as the crow flies, and about four by rowing boat, skirting mangrove-clad banks infested with *Glossina palpalis*. The frontage is to the N.E. on a wide channel exposed to two tidal currents, one from the seaward channel in the S.E. and the other from the mouth of the Sherbro river (which forms the approach to Bonthe). The prevailing breeze is S.W., and currents of air generally make it cooler than Bonthe. The native houses are without much space around them, and thus are in general fairly well looked after and kept free from refuse and vegetation. The town is cleaner than Bonthe, but the area of streets is much less, and long grass has not to be coped with.

On the other hand, crabs are so numerous that the side ditches are constantly obstructed by earth thrown out of the holes, and this with the lack of outfall results in the formation of numberless pools, and entails endless labour to keep them free. In addition, the chief drains are apt to be easily silted up by the tide, and pools with larvae receive special mention in the sanitary reports as occurring in these with great frequency.

The water supply consists of one Government concrete tank with catchment roof, and numerous private wells, all shallow and some wide-mouthed owing to crumbling soil. Considering the scarcity of carpentering material, the attempts to make suitable covers are fairly creditable, but are none the less wholly inefficient, and very many wells have no cover. Water being near the surface and the soil loose there is a tendency to multiply wells, a fresh one being made after a short interval. A single compound may thus have several, only the last formed being in regular use. In an open area behind the town, and within 400 yards of the sea-front, some forty shallow wells and water-holes could be found in a space of two acres. In spite of these facilities for mosquito breeding, comparatively few were actually found to harbour larvae, and these were mostly in uncovered water-holes rather than in wells of attempted better construction.

The chief problems for the sanitary staff at York Island are thus the wells and crab-holes and lack of drainage fall. Mosquitoes

were again found here sheltering in holes during the day, and from the number of holes and the non-porous nature of the soil, it appears likely that they may also be here a source of mosquito breeding in the rains. At the present season, as at Bonthe, they are little complained of, but are admitted to be always a pest during the summer months. Yet the larva index at York Island taken on previous occasions appears to have been extraordinarily low (vide above). The source of larvae on these occasions are stated as 'barrel, old boat, calabash, native pot; not in wells.' Crab-holes are not mentioned, and none of the dates (March, May and June, respectively) coincide with the wet period. From the surrounding mangrove swamps one may suspect that *Mansonioides uniformis* is a prevalent species, but data of this nature are wanting.

The manager of the Sierra Leone Old Co. lately cleared his compound of crab-holes by pouring down boiling water and tar; the crab is either killed when trying to escape or perishes miserably in the hole, which is then rammed hard with mud.

Adult mosquitoes caught at York Island were:—*Culex decens* in a well; *Uranotaenia annulata* in crab-holes; *Ochlerotatus* (?*nigrocephalus*) in crab-holes.

Larvae found:—*Culex duttoni* and *Culex tigripes*, hatched from muddy water-holes amongst wells; *Culiciomyia* (? *freetownensis*) hatched from an open well; *Anopheles* (*Pyretophorus*) *costalis* in two stagnant water-holes amongst wells. Again no *Stegomyia* were found, either larva or adult. No cases of fever came to our notice at York Island.

An attempt was made to ascertain a few facts in regard to the mortality of Sherbro in previous years, but without much success. The only post-mortem register to be found commenced in June, 1912, and contained only five entries, mostly of judicial cases and none of interest to fever investigation. The death register went back to 1908, but as several pages had been officially cancelled, and as entries for the last year did not include several deaths which were ascertained by enquiry to have occurred, this volume also was of little use. So far as it can be taken as an index, no unusual mortality or special prevalence of febrile disease is revealed. The following list gives the numbers of deaths in each year from

Blackwater and from 'Fever' (variously entered as malaria, pernicious malaria, and intermittent fever). Most of the latter were uncertified, and not attended during life by a doctor:—

	Blackwater	'Fever'
1908	0	... 2
1909	2	... 1
1910	1	... 3
1911	2	... 3
1912	0	... 5
1913	1	... 1
	6	15

There was at least one other fatal case of blackwater fever in 1913, and another, non-fatal, in the same year, and a fatal case in 1912.

Copies of the nosological table for the Annual Hospital Return were found for the years 1911, 1912, and 1913. It was observed, however, that these did not include private cases, and in fact two cases out of three of blackwater fever during the previous year were on this account not found in the Hospital Records, but were heard of by personal enquiry of the European residents. Since there are 50 European non-officials in Sherbro and some 30 Syrians who form the clientèle of the Medical Officer's private practice, as compared with only two European officials, it is obvious that records which take no note of fevers, etc., amongst these, the true non-immunes, are of little or no value for our purpose.

Clinical notes of cases of any kind were not to be found, and thus it is impossible to trace and study the notes of the medical attendant on cases entered, whether in the Register of deaths or in the Hospital Statistics, e.g., as blackwater, malignant malaria, etc.

Bonthe as a place of residence for Europeans has previously been regarded as rather unhealthy, though it does not seem to have ever borne a reputation which could be described as sinister. Medical Officers say that the cases of blackwater fever met with in Bonthe are generally very serious. Old residents, while cognisant of blackwater and occasional fatal cases of 'Fever,' do not admit having seen 'Yellow Fever' in the sense in which white men use the term, and there is no history of any type of fever in epidemic form. One elicits the same opinion from some of the

educated native pastors and teachers born in Sherbro; and Father Noirgean, of the Roman Catholic Mission, who has spent seventeen years in Bonthe and who takes the most intelligent interest in the welfare of the people, makes the same statement. No case of yellow fever was recorded from Sherbro during the epidemic period in 1910-11 in Freetown.

Ths comparative unhealthiness of Bonthe (which perhaps lacks demonstration), may so far as Europeans are concerned be sufficiently explained by the local climatic conditions and circumstances of life and work in a relaxing atmosphere, lack of vigour generally making itself felt amongst those who live where facilities for exercise are insufficient and outside interests are few. Under these conditions local endemic fevers imprint themselves rather heavily upon the local health statistics. Whether one of these endemic fevers in Sherbro is yellow fever is not yet shown, and if the mosquito index can be kept down to its present low figure, it seems happily probable that there may be no further opportunity of proving its presence.

Some notes by Dr. Johnson on a visit to Yonni are appended.

J. M. D.

Visit to Yonni on Sherbro Island

This village was visited by one of us with the District Commissioner of Bonthe on February 2nd and 3rd. It is a large straggling village on the coast of Sherbro Island, about five miles from Bonthe.

The District Commissioner had called together all the inhabitants of the village and surrounding district, and he explained to them my mission, so that I had the opportunity of seeing every case of sickness in the village, and of inspecting every hut and compound in the place.

The village is divided into three parts by mangrove swamps which turn inland, in one of which is a fair-sized stream. The higher ground at the back of the village is shut in with trees and thick bush. Inland is an extensive area of dry farm land.

The huts are of mud, with palm roofs, and are fairly well built. The town is fairly clean, but round every hut are strewn

numbers of empty trade-gin bottles. There is one deep well with good water, in which no mosquitoes are breeding. Three other wells exist—practically mere spring-fed pools. These latter are of dirty water and contain a few *Culex* larvae, but the water is so constantly disturbed that they cannot be a cause of many mosquitoes. Water does not appear to be stored in coolers or water receptacles, only one of which I found in the whole village, and that contained no larvae.

The people welcomed the presence of a doctor, and quite twenty came for treatment. Most cases were either rheumatic or of a surgical nature, and only two complained of fever. One, a child of nine months, was said to have fever, but the main complaint in her case was of abdominal colic, vomiting, and oedema. Blood examination showed no parasites, but an eosinophilia of 36·5 per cent. The other case of fever was that of a man who complained of pain over the left hypochondrium and occasional attacks of fever at night. His spleen was palpable, and blood examination showed scanty subtertian parasites and crescents.

Glossina palpalis abounds in the mangrove swamps between the different parts of the village, and as these are being constantly crossed the flies are found in the village itself. A *Tabanus* (*T. fasciatus*) is common. Mosquitoes swarm in the village at night, but of 65 specimens which I caught during an hour or so in my house in the evening, 64 were *Mansonioides uniformis*, and one was *Culex consimilis*. The former is a mangrove breeding mosquito; and the absence of *Stegomyia* larvae in the village, and of adults in the large number of mosquitoes caught, shows that in the dry season no disease depending upon that mosquito could occur.

W. B. J.

Blood-sucking Diptera caught in Bonthe District, January 30th to February 12th

A. CULICIDAE

(1) *Uranotaenia annulata* (Theo.)*

The most common species about Bonthe. Male and female adults caught in crab-holes and holes in trees in many parts of Bonthe and York Island. One specimen caught in the Medical Officer's bungalow at Bonthe. Specimens bred from larvae found in a well at Bonthe.

(2) *Culex insignis* (Carter)

A very common *Culex* at Bonthe. Specimens were caught in crab-holes and holes in trees in many different compounds at Bonthe. On four occasions a small red mite was preying upon the specimen.

(3) *Culex decens* (Theo.)*

One female caught in a well at York Island. Several bred from larvae from a well at Bonthe.

(4) *Culex tigripes* (Grp.)*

Bred from larvae taken from water-barrel in a compound at Bonthe. Also bred from a muddy pool amongst the wells at York Island.

(5) *Culex consimilis* (Newst.)

Single female caught in chief's house at Yonni.

(6) *Culex duttoni* (Theo.)*

Single male bred from muddy pool on York Island.

(7) *Culiciomyia ? sp. nebulosa* (Theo.)

Caught in crab-holes and holes in trees at Bonthe.

(8) *Culiciomyia ? sp. freetownensis**

Caught in crab-holes at Bonthe; bred from larvae in muddy pool at York Island.

(9) *Mansonioides uniformis* (Theo.)

Great numbers of females caught in chief's house at Yonni, and sent from another house at Yonni later. One female caught in the Medical Officer's house, and another in the rest-house at Bonthe. One female caught in crab-hole at Bonthe.

(10) *Taeniorhynchus annettii* (Theo.)

Single female caught in morning in Medical Officer's house at Bonthe.

(11) *Ochlerotatus ? sp. nigrocephalus* (Theo.)*

Caught in crab-holes at Bonthe and York Island; also bred from a well at Bonthe.

(12) *Ochlerotatus ? sp. caliginosus* (Graham)

Caught in crab-holes at Bonthe.

B. Other Blood-sucking Diptera

Glossina palpalis.

Tabanus fasciatus (Fabr.)

,, ? *congoensis* (Ricardo).

,, *obscurissimus* (Ricardo).

Chrysops longicornis (Macq.)

Hippobosca ? *sp.* (from large fish eagle—*Haliaetus vocifer*), J. M. D.

Phlebotomus ? *sp. duboscqii.*

Culicoides ? *sp.*

N.B.—Specimens of Culicidae in which the larvae were found are marked with an asterisk in the above list.

Culicine Larvae obtained in Bonthe District

(1) *Uranotaenia annulata* (Theo.)
From a well in Bonthe.

(2) *Culex decens* (Theo.)
From a well in Bonthe.

(3) *Culex tigripes* (Grp.)
(*a*) From a water barrel in a compound at Bonthe.
(*b*) From a water-hole amongst the wells at York Island

(4) *Culex duttoni* (Theo.)
From a water-hole amongst the wells at York Island.

(5) *Culiciomyia* ? *sp. freetownensis*
From a well at York Island.

(6) *Ochlerotatus* ? *sp. nigrocephalus* (Theo.)
From a well at Bonthe.

(7) *Anopheles* (*Pyretophorus*) *costalis*
From pool near York Island settlement.

(8) *Anopheles* (*Myzomyia*) *funesta*
From marshy pool at back of Bonthe.

W. B. J.

REPORT ON YELLOW FEVER INVESTIGATION IN FREETOWN, SEPTEMBER, 1913, TO MARCH, 1914

BY

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1. *Introductory*

Dr. Dalziel arrived in Freetown on September 14th, 1913, to relieve Dr. Butler, who had been engaged upon clinical and laboratory work on yellow fever for the previous four months.

Dr. Johnson arrived on October 26th, and brought with him a complete laboratory equipment, as well as a number of guinea-pigs for experimental work. Alteration of premises to accommodate both apparatus and animals was already in progress, and before long we were able to remove from the previous limited quarters used for the clinical pathology work of the Colonial Hospital, and to unpack and dispose the new apparatus so as to work under quite satisfactory conditions.

A visit to Bonthe (Sherbro) occupied two or three weeks in January and February. A report on this was forwarded to the Commission on February 17th.* Dr. Johnson made a preliminary visit to report on the conditions in some of the smaller towns in the estuaries north of Freetown, with a view to considering their suitability as a locality for yellow fever research. His report is attached.

2. *Clinical Work*

The general line of research has been the clinical examination of all febrile cases presenting themselves for treatment, whether as dispensary out-patients or admitted to the wards, and much the greater part of our time has necessarily been occupied in careful routine examination of the blood in each case.

As there did not appear to have been any recognisable case of

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* *Vide* p. 527 *supra*.

yellow fever in Freetown during the period since the work of the Commission began, it was thought that the careful search for the bodies described by Dr. Seidelin as *Paraplasma flavigenum* in the blood of every case showing pyrexia, not obviously due to sepsis or some other readily recognised cause, would yield information of some value even if the results should be entirely negative. This line of study is thus based on the assumption that the *Paraplasma flavigenum* of Seidelin is the virus of yellow fever, and that it is a demonstrable parasite, and therefore the microscopic examination of the blood has been, we think justifiably, the first and most exacting part of our work here.

The importance of the search for the parasite in the diagnosis of cases which are actually suspicious is widely admitted. If it could be demonstrated without a doubt also in a proportion of the mild fevers or simple indispositions of the natives, the theory of the endemic persistence of yellow fever would be confirmed At the same time opportunity would be given of proving or disproving among other things the idea that the infective period in man lasts for only three days.

Bacteriological work has been mainly concerned with the diagnosis or exclusion of typhoid by the Widal reaction and by blood culture.

The total number of cases studied is 461. Of these only one, and that the last case in the series, could be diagnosed as yellow fever. A tabulated list is given below in Table I:—

TABLE I

461 CASES OF PYREXIA IN FREETOWN, EXAMINED BETWEEN SEPTEMBER 17TH, 1913, AND MARCH 18TH, 1914

A. Pyrexia due to Malaria:—

Subtertian Malaria ... ... (parasites demonstrated)	171	(Complications: Pneumonia, 1; Broncho-pneumonia, 2; Bronchitis, 1; Pertussis, 3; Adenitis, 2; Tonsillitis, 1; Mitral disease, 1.)
Quartan Malaria	46	(Complications: Broncho-pneumonia, 2; Pertussis, 1; Abscess, 1; Died of infantile diarrhoea, 1.)
Quartan + Subtertian Malaria ...	3	
Benign Tertian Malaria	1	

B. Pyrexia due to serious diseases of Respiratory tract :—

Pulmonary Tuberculosis	6	
Pneumonia	13	
Pleurisy	9	(Also Malaria, 1.)
Empyema	1	
Bronchiectasis	1	

C. Specific and other Fevers :—

Pertussis	4	
Trypanosomiasis	6	
Enteric Fever	2	(Widal reaction positive.)
Haemoglobinuric Fever	1	
Varicella	1	
Specific Parotitis	1	
Meningitis	1	
Rheumatic Fever	1	
Yellow Fever	1	

D. Pyrexia of less certain origin :—

(1) Probably Malaria	37	(No parasites found by blood examination, but either pigmented leucocytes present or a high percentage of large mononuclear cells in a differential blood count. See table of blood counts on these cases attached, Table 3.)
(2) ? *Paraplasmosis*	3	(Slides and notes sent to Y.F. Commission on 24th February, 1914.)*
(3) *Mild Respiratory diseases :—*		
Coryza...	20	
Bronchitis and Catarrh ...	25	(Complicated by Helminthiasis in 4 cases.)
(4) *Diseases of Digestive tract :—*		
Dysentery	2	
Diarrhoea	4	(Also Malaria in one case.)
Constipation	9	
Dyspepsia	6	
Gastro-enteritis	1	
Hepatitis (alcoholic)	4	
Cirrhosis of liver	2	(One fatal.)
Stomatitis	2	
Obstructive Jaundice ...	1	(Died—P.-m. Said to be a pancreatic tumour obstructing common bile duct.)
†Catarrhal Jaundice	1	
†Jaundice of uncertain origin...	1	
? Malignant abdominal disease	1	
Abdominal pain of uncertain origin	1	

* *Vide* Appendix E. † For notes on these cases *vide* Appendix A.

(5) *Helminthiasis*	15	(In these cases mild pyrexia was present, probably due entirely to the worm infection—ankylostome, taenia, etc.)
(6) *Various* :—		
Aneurism	1	(Died with rupture of abdominal aneurism.)
Lumbago, chr. Rheumatism, etc.	5	
Syphilis	1	
Cerebral Syphilis	1	
Adenitis	5	
Lymphadenoma	1	
Myeloid Leukaemia	1	
Splenic anaemia	1	
Rickets	1	
Morbus cordis	2	
Oedema	1	
Concussion	1	
Periostitis	1	
Synovitis	1	
Septic absorption	1	
E. *Not Diagnosed*	33	
Total	461	

Most of the undiagnosed cases in Section E were trivial illnesses, and in the majority of cases the patients were seen only once in the out-patient department. Blood examination showed no parasites and the differential leucocyte counts showed no abnormality.

3. *Nationality of Cases*

The cases represent the following nationalities, the majority being from Freetown itself:—

Sierra Leonian (i.e., descendants of liberated Africans of many countries)	325
Native tribes (Mendi, Timne, Susu, etc.)	94
Half-caste	4
Syrians	17
Europeans	21

The number of Syrians examined is only 17, of whom 11 or 64·7 per cent. were diagnosed as malaria:—

TABLE 2

17 SYRIANS EXAMINED

Subtertian Malaria	10
Quartan Malaria	1
Haemoglobinuric Fever	1
Cirrhosis of Liver	1
Dyspepsia	1
Constipation	1
Not diagnosed	2 = 17

Percentage of Malaria in Syrians = 64·7

As these are non-immunes and often recent arrivals, and live amongst the natives with many of the disabilities of 'poor whites,' it is a matter for regret that more of them did not come to hospital during our period of work. Many of them are able to pay private fees and thus prefer to go to a practitioner. There are eight qualified native practitioners in Freetown. It is likely that a better opportunity for studying a series of Syrians, including some children, might be obtained in some of the smaller native towns such as Kambia, referred to in Dr. Johnson's report. No indication exists at present of the Syrians suffering in the early months of residence in Freetown from a pernicious type of fever, and they now appear to be arriving in greater numbers each year, sometimes with their families, very many of them proceeding to settle for trade in various coast or inland towns.

The list includes only a few Europeans, viz., 21. One of these was a definite case of yellow fever, and is separately reported on page 574 (Appendix D). Several of the others were seen on board suspected ships (Lagos having been under quarantine from time to time of late), a blood examination being made on account of existing fever at the time of inspection.

4. *Malaria*

In 221 cases out of 461, or 48 per cent., a diagnosis of malaria was made on the strength of finding, in addition to clinical symptoms, the parasites present in sufficient numbers to justify that diagnosis to the exclusion of any other, apart from complications. If the 'probable' cases are included, the diagnosis resting on other grounds in the

absence of parasites in the peripheral blood, the number is 258 cases of malaria, or 56 per cent. (vide Table 1, A and D).

Table 3 gives the different leucocyte count in 37 cases probably malarial:—

Table 3

Blood Counts in Cases probably Malarial, no Parasites being found

Case No.	No. of cells counted	Polymorpho-nuclears	Lympho-cytes	Large mono-nuclears and transitionals	Eosino-phils	Mast cells
2	300	42·5	30·0	26·5	1·0	—
3	270	45·0	35·5	15·0	3·5	1·0
5	250	36·0	20·0	43·2	0·8	—
28	250	44·6	35·4	20·0	—	—
37	300	58·7	25·4	15·2	0·7	—
38	350	62·5	18·4	17·1	2·0	—
39	250	40·8	41·6	16·4	1·2	(3·0)
44	280	42·8	39·3	14·2	3·8	—
50	300	47·1	42·2	9·5	1·2	—
73	300	47·0	29·0	17·4	6·6	—
85	400	10·8	79·3	8·4	1·4	—
108	300	37·0	47·2	15·3	0·3	—
159	220	36·3	40·9	20·0	2·8	—
160	205	36·6	41·4	20·5	1·5	—
163	300	35·7	39·3	24·3	0·7	—
164	310	50·0	27·1	10·6	12·0	0·3
168	250	75·6	5·2	12·8	6·4	—
178	260	66·2	19·2	12·3	2·3	—
179	210	51·4	23·8	23·8	1·0	—
181	170	70·3	5·3	23·4	1·0	—
183	300	45·0	26·6	20·0	8·4	—
185	210	42·8	36·7	15·2	5·3	—
186	270	40·7	33·3	22·3	3·7	—
201	300	46·6	28·4	20·0	5·0	—
202	250	59·6	24·0	14·8	0·8	0·8
215	320	56·3	25·0	17·5	0·6	0·6
230	330	33·6	40·0	15·6	11·0	—
233	310	71·0	14·0	14·0	1·0	—
234	200	44·5	27·0	23·5	5·0	—
235	220	14·0	41·7	19·0	25·2	—
244	220	41·0	27·2	30·0	1·8	—
251	260	19·4	68·4	9·0	3·5	—
257	300	48·3	31·7	20·0	—	—
278	220	53·0	28·3	15·5	2·3	1·0
357	400	28·7	43·3	25·7	2·0	0·3
414	300	35·3	41·7	10·7	11·3	1·0

It is apparent that the incidence of malarial infection is high, and this is emphasised when we consider the cases in children. Tables 4 and 5 show the incidence of malaria amongst children under 5 years of age:—

TABLE 4

FEBRILE ILLNESSES IN 45 CHILDREN UNDER 2 YEARS OF AGE

Subtertian Malaria	23
Quartan Malaria	11
Quartan + Subtertian	1
Probably Malaria	4
Pertussis	1
Bronchitis	1
Gastro-enteritis	1
Septic Stomatitis	1
Not Diagnosed	2

Malaria Percentage = 86·6

TABLE 5

FEBRILE ILLNESSES IN 48 CHILDREN BETWEEN 2 AND 5 YEARS OLD

Subtertian Malaria	20
Quartan Malaria	17
Quartan + Subtertian	2
Probably Malaria	1
Bronchial Catarrh	1
Pertussis	1
Meningitis	1
Helminthiasis	2
Congenital oedema	1
Rickets	1
Not Diagnosed	1

Malaria Percentage = 83·3

This represents malarial disease in Freetown, the symptoms in these cases being coincident with and attributable to the parasites found.

Evidence regarding malarial infection in the child population of Sierra Leone may be briefly stated as follows:—

(1) Dr. Orpen, taking the *Splenic index* of 1,100 school children in Freetown, 1911, of ages 3-12, found 16·1 per cent.

(2) Dr. Butler, as Yellow Fever Investigator, in a control examination of 100 apparently healthy school children in Freetown, September, 1913, of ages up to 10, found malaria parasites present in 49 per cent., of which 8 per cent. were Quartan, and *spleen palpable* in 42 per cent.*

(3) In Bonthe (*vide* Report on visit to Sherbro, February, 1914†), Dr. Dalziel found a *splenic index*, in 254 school children of ages up to 10, of 54 per cent.

(4) In Port Lokkoh, Dr. Johnson found in 110 school children a *splenic index* of 77·3 per cent.‡

* *Vide* pp. 399, 400 *supra*. † *Vide* p. 529 *supra*. ‡ *Vide* p. 567 *infra*.

The assumption that most febrile diseases of children in the tropics are malarial is based on the observations of various workers on tropical fevers, perhaps beginning with Koch, showing the great frequency with which the malaria parasite is found in the blood of children. In Freetown 45 of our patients were infants under 2 years of age, and of those 86·6 per cent. were attributable to malaria; 48 were between 2 and 5 years, with 83·3 per cent. of them malarial. If yellow fever exists to an equally wide extent amongst young children, and wherever the *Stegomyia* is the predominant domestic mosquito the presumption is to some minds a tempting one, then there must be a large proportion of children doubly infected with *Plasmodium* and *Paraplasma.* This is by no means impossible, but as the latter body is infinitely more difficult to detect it will be very easily overlooked, especially when the attention is diverted by the presence of the more familiar parasite. It has also to be noted that to confuse a fairly grown *Paraplasma* with a very young subtertian ring is technically a pardonable error, and if both occurred in one blood smear it is doubtful if anyone but an expert would be justified in diagnosing the condition—from the blood examination alone—as other than malaria.

5. *Jaundice*

In 28 cases, jaundice is noted as present in various degrees. The diagnosis arrived at in each of these is tabulated below (Table 6).

TABLE 6

28 CASES SHOWING JAUNDICE

Subtertian Malaria	10
Quartan Malaria	2
Probably Malaria	2
Haemoglobinuric Fever	1
Broncho-pneumonia, etc.	3
Dysentery	1
*Catarrhal Jaundice	1
*Obstructive Jaundice	1
Cirrhosis of Liver	1
*Hepatitis	1
Malignant abdominal disease	1
Myeloid Leukaemia	1
Trypanosomiasis	1
*Pyrexia of uncertain origin	1
†Yellow Fever	1

The number of malarial cases showing jaundice is 14, or 5·4 per cent.

* For notes on these cases *vide* Appendix A.

† For special report on this case *vide* Appendix D.

6. *Other Fevers*

Two cases proved to be *Enteric*, with a positive Widal reaction for *B. typhosus.* In one of these cases the reaction was positive up to dilutions of 1/800, while negative except for group reactions in 1/20 dilutions for *B. paratyphosus* A and B. In four other cases the Widal reaction was tested with negative result, and in three cases blood cultures were made which proved sterile.

On the whole it appears likely that general laboratory work on endemic fevers in future might very usefully be directed to the question of typhoid and the allied fevers, as the incidence of these in Freetown seems at present to be entirely unknown, and both of our cases occurred in native patients. An early blood culture between the 2nd and 5th day of illness in each case of pyrexia of uncertain type might lead to the discovery of infections of the typhoid group, and with malaria also excluded the number of those possibly to be classed under the yellow fever group would be still further reduced.

In regard to other fevers now believed to belong to the yellow fever group, e.g., *Dengue*, *Pappataci Fever*, *Three-day Fever*, etc., we have seen amongst our 461 cases nothing to suggest any one of these.

7. *Infant Mortality*

One has always been aware of the importance of any special cause of a febrile nature for a high infant mortality, but a definite investigation of this subject has not been possible along with our laboratory work. We are of opinion that no special cause can be quoted except *Malaria* and *Congenital syphilis*, both of which are undoubtedly responsible as the main factors in cutting short infant life in Freetown. A record book is kept of the causes of death of all infants concerning whom information can be obtained from all married women presenting themselves at the dispensary or admitted to hospital. As the records are entirely based on the mother's information, not much of a definite nature can be ascertained by an analysis of the figures. Certainly no hint appears of anything resembling a '*fièvre à vomissement noir des enfants*.'

8. *Animal Experiments*

1. *Examination of blood of animals in Freetown*

A note on examination of blood from dogs and rats up to date was forwarded to the Commission along with slides* and specimens of ectoparasites on the 19th of January, 1914. Identifications of the latter have been received from the various authorities who kindly examined them for us.

Rats caught in the town and brought to the Colonial Hospital, and stray dogs impounded by the police for destruction if unclaimed, were obtained for blood examination—50 rats and 42 dogs respectively.

The chief ectoparasites of rats in Freetown are the fleas *Xenopsylla cheopis* (Roths.) and *X. brasiliensis* (Baker), the latter being less common. A louse, *Polyplax spinulosus* (Burm.), was found in 17 cases. A Gamasid, *Laelaps sp. nr. echidninus* (Berl.), was found on 22 rats.

On stray dogs the chief parasite was the dog flea, *Ctenocephalus canis* (Curtis), *Rhipicephalus sanguineus* (Latr.) was not uncommon; of other ticks, *R. simus* (Koch) and a larval *Amblyomma* were each found once. It was impossible to attach any association between any of these ectoparasites and any unusual bodies in the blood.

(*a*) *The blood of dogs*: It was expected to find *Babesia* in some proportion of cases, and it was hoped that one might possibly find parasites resembling the *Paraplasma flavigenum* in some cases to support the idea that domestic animals may prove to be a reservoir of the yellow fever virus. No indication of this was seen in the 42 dogs examined. Bodies doubtfully resembling *Babesia* were present in 5 cases. Trypanosomes of the *Tryp. brucei* type were observed in only 2 cases.

(*b*) *In regard to rats*, the commonest blood parasite was *Tryp. lewisi*, which was present in 30 out of 50 rats, or 60 per cent. Minute rod-shaped bodies (? pseudoparasites) within the red cells were observed in 12, or 24 per cent. Stained smears containing these, and a few showing doubtful bodies of a different nature were forwarded to the Commission on the 19th of January, and unstained slides were sent on the 18th of February, 1914.*

(*c*) *Eight native guinea-pigs* showed nothing abnormal.

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* *Note by Commission.* The slides were examined by Dr. C. M. Wenyon, Director of Research in the Tropics to the Wellcome Bureau of Scientific Research, who considered that in practically all cases the bodies marked were nothing but artefacts. In the rat films *Trypanosoma lewisi* occurred, and, in the red cells, rod bodies which have been frequently seen and are, according to Laveran, the result of basophilic change.

2. *Inoculation of animals*

(*a*) One guinea-pig was inoculated with 5 c.c. of blood from a very doubtful case of *Paraplasmosis.* No parasites appeared in the blood, and the animal developed no symptoms.

(*b*) One guinea-pig was inoculated with 5 c.c. of blood from a case of subtertian malaria, showing such minute parasites that it was considered that they might have been mistaken for *Paraplasma.* Nothing abnormal was observed.

(*c*) Inoculation was made into a guinea-pig from a case diagnosed as yellow fever. After inoculation the temperature showed a mere temporary rise to 102 on the fourth day, but no parasites were seen in the blood on daily examination, and the animal showed no signs of illness. (A control animal inoculated with blood from a healthy individual showed no rise of temperature beyond that usual to the species.) This experiment, however, was unsatisfactory, as the patient did not arrive until late in the acute stage, and had reached the 8th day of his illness before inoculation was made. No parasites were observed in the patient's own blood.

(No guinea-pigs for inoculation were available at the date of the paraplasmosis case No. 102.)

9. *Sanitation*

1. The report on our visit to Bonthe, describing the conditions found there, was forwarded on February 17th.*

2. *Freetown.* The majority of European officials, civil and military, are in segregation by living at a distance and mostly at an elevation of several hundred feet above the town. The numerous Europeans, whether officials or mercantile, etc., whose duties involve residence in the town, have little to complain of in regard to mosquitoes. If tropical sanitation is to be gauged by mosquito incidence the condition of Freetown must be regarded as having been brought to an exceptional degree of immunity in comparison with many other coast towns. So far as our experience goes, during the period from September to March an occasional mosquito, usually a *Stegomyia* or a *Culiciomyia*, may be seen, but if several are observed within a week the fault can usually be put right by dealing

* *Vide* page 527 *supra.*

at once with a neighbouring compound where some receptacle has temporarily escaped the vigilance of the Sanitary gang.

The following table, along with other references, gives an indication of the state of matters as regards the mosquito-breeding in domestic water receptacles, but it must definitely be pointed out that wells in compounds are not included :—

TABLE 7

LARVA INDEX IN FREETOWN, 1913 (BASED ON DAILY RETURNS OF LARVAE FOUND)

Month	Larva index	Observations by	No. of compounds inspected	Remarks
February	2·8%	Medical Officer of Health (Dr. Allan) ...	?	
May ...	5·6%	Medical Officer of Health ...	31	
August ...	4·0%	European Sanitary Inspector	153	
September	5·6%	Native Sanitary Inspector ...	141	
October ...	3·2%	European Sanitary Inspector	89	Of these, *Stegomyia* = 75%
November	4·8%	Native Sanitary Inspector ...	121	" " = 33%
December	3·2%	Medical Officer of Health ...	163	" " = 16%

For comparison we may refer to the report on the Freetown epidemic by Sir Rubert Boyce, who found in August, 1910, by a house to house examination, the larva index in Freetown to be 44 per cent. in 200 houses examined, but after a few weeks anti-mosquito campaign this was reduced to 7 per cent. Wells were apparently included. It is added 'The larvae almost invariably found during my visit (July to August) were those of *Stegomyia fasciata*' (Report on Certain Outbreaks of Yellow Fever in 1910 and 1911, Appendix B).

Dr. Orpen, Medical Officer of Health, gives the Quarterly Larva Index, Freetown, taken 16th to 19th March inclusive: 250 compounds representing 10 divisions of the town show a larva index of 0·4 per cent., i.e., larvae (*Culex sp.*) were found in one compound only, in a barrel. The compounds represent the same area inspected by Dr. Allan in the end of February, 1913, with a larva index of 2·8 per cent. (vide Table 7).

It must again be emphasised that domestic wells are excluded from these present surveys, and that no authority exists under which wells in compounds, however useless, can be closed. The remedy for this is now in progress, viz., an increased municipal pipe-borne water

supply, since in present circumstances opposition on the ground of insufficient water for emergency, risk of fire, etc., has proved successful in preventing closure.

During four weeks preceding the date of the most recent larva survey (March 16th-19th) screened samples of water containing larvae collected in various parts of the town by the Medical Officer of Health have been kept in the laboratory and the hatching mosquitoes identified. Dr. Johnson gives the following table of identification of these:—

TABLE 8

CULICINE LARVAE OBTAINED IN FREETOWN

Date	Locality	Larvae
16.2.14	Outfall, Moore's Brook	*Culex decens* (Theo.)
16.2.14	Pool in Sander's Brook	*Culex decens* (Theo.).
16.2.14	Pool in Sander's Brook	*Stegomyia fasciata* (Fabr.)
16.2.14	Another pool in Sander's Brook	*Anopheles* (*Pyr.*) *costalis* (Theo.)
17.2.14	Barrel of water in Victoria Park	*Stegomyia fasciata* (Fabr.) *Culex decens* (Theo.)
17.2.14	Pool in Peter's Brook	*Culex decens* (Theo.) *Anopheles costalis* (Theo.)
17.2.14	Pool in Sander's Brook	*Culex decens* (Theo.) *Anopheles costalis* (Theo.)
18.2.14	Tub in compound in Fourah Bay Road ...	*Culiciomyia nebulosa* (Theo.)
18.2.14	Tin pan in house in Fifth Street	*Culiciomyia nebulosa* (Theo.)
18.2.14	Native water-pot in Hope Street	*Stegomyia fasciata* (Fabr.)
20.2.14	Pool in Sander's Brook	*Culex duttoni* (Newst.) *Culex tigripes* (Grp.)
23.2.14	Pool in Agugumaga Brook	*Culex duttoni* (Newst.)
24.2.14	Tin pan in a Trading Co.'s compound	*Stegomyia fasciata* (Fabr.)
26.2.14	Tub in Alligator Brook	*Culex decens* (Theo.)
24.2.14	Pool in Agugumaga Brook	(*Culex ? sp.*—did not hatch out)
28.2.14	Pool in Nicol's Brook	*Anopheles costalis* (Theo.)
28.2.14	Pool in Nicol's Brook	*Anopheles costalis* (Theo.)
10.3.14	Pool in Mountain Cut Brook	*Culex decens* (Theo.) *Anopheles costalis* (Theo.)
12.3.14	Pool in Mountain Cut Brook	*Anopheles costalis* (Theo.)
13.3.14	Pools in Nevill's Brook	*Anopheles costalis* (Theo.)

In addition Cyclops, Chironomid larvae and Ephemerid larvae were common.

Stegomyia hatched out in four samples out of 20, alone in three instances, with *Culex decens* in one.

Adult mosquitoes caught in the premises in the town occupied by ourselves, or in the Colonial Hospital, proved to be either *Stegomyia fasciata* or *Culiciomyia nebulosa*, with a rare specimen of *Anopheles costalis.*

No *Culicoides* or *Phlebotomus* have been observed by us during our six months, but they were not altogether absent from Bonthe, and they are stated to be abundant in some parts of the Protectorate.

Turning to the mosquitoes breeding in wells, the following details are from a special inspection of these by Dr. Allan, Medical Officer of Health, larvae being collected and afterwards hatched out. 418 wells were examined in May to August, 1913, a specially prepared dredging net being employed. *Larvae were found in* 22·5 *per cent. of the wells examined.*

Of the larvae found 75 per cent. were Culicine. All the *Anopheles* found were *A. costalis*, and these occurred in 28 wells. *Stegomyia fasciata* was found in 14 per cent., and in one well at a depth of 64 feet. *Culex decens* was definitely identified in 17 and doubtless occurred in some of the 36 others in which a *Culex* was present, but no identification made. *C. tigripes* and *C. insignis* occurred once each.

Thus *Stegomyia* may be regarded as forming 14-15 per cent. of these finds, but the relative numbers in each catch cannot be stated.

From this and from the table of observations in February and March, 1914 (Table 8) *Culex decens* would appear to be perhaps the commonest species in Freetown—*qua* species only, without reference to absolute numbers.

10. *Epidemiology and Endemicity*

Some facts and conclusions

If the above research be regarded as directed towards the proof or otherwise of the endemicity of yellow fever in Freetown at the present time, the general results must appear to be practically negative.

Two main facts, or at least incidents, of importance, have emerged:—

(1) During six months' clinical investigation of several hundred cases, in only one were bodies recognised on good authority as probably *Paraplasma flavigenum* observed.

(2) At the end of the period one case of yellow fever was diagnosed in a European stationed on the railway line at a place some 60 miles from Freetown.

Whether the former individual is to be considered a mild infection or a microbe carrier, it is possible to quote his case on the side of those who believe that yellow fever exists all the year round in Freetown. It requires more than an isolated case, however, to establish the endemic theory, and if similar cases are an important factor in the maintenance of the disease one should have expected to find the parasite in the blood of at least a few more of our 461 patients with pyrexia. Dr. Seidelin has mentioned the occurrence of yellow fever bodies in two patients not suffering from yellow fever (*Journ. of Path. and Bact.*, XV, Jan. 1911, p. 282). One might presume in our case the persistence of the virus after a previous infection, and the patient had resided elsewhere than in Freetown, besides having been in Lagos.

Thus whatever may have been expected of the method, systematic blood examination for *Paraplasma* in several hundred cases of pyrexia in Freetown can scarcely be said to have revealed the existence of endemic yellow fever.

One must not be content with this, however, as even in undoubted cases of yellow fever, it appears from the accounts of others that a careful search of several slides has sometimes been required to find a single or a few parasites, and one has never had unlimited time at disposal for the examination of each case. It would perhaps have been better to have concentrated our attention upon the comparatively few hospital in-patients and to have ignored those attending the out-patient departments—cases which are most unsatisfactory from the investigator's point of view, but which we have included as likely to produce mild cases of *Paraplasma* infection which would be essential in establishing the endemic theory. In this connection, one may say that if one hour be allowed for the routine examination of a single slide to decide as to the presence

of the malaria parasite, at least three or four hours, and probably more, might be regarded as an equivalent time for the detection of a parasite which its discoverer admits is quite minute in the stage in which it is likely to be abundant, and quite scarce in its larger forms (*Y. F. Bur. Bull.*, Vol. I, No. 7, Nov. 1911, p. 253).

Notes of three possible cases of *Paraplasmosis*, with slides, were forwarded to the Commission.* One of these, viz., No. 102, certainly appeared to contain bodies which Dr. Seidelin, to whom the slide was referred at Lagos, regarded as *Paraplasma*. It is unnecessary to refer again to these until they have been examined by other authorities at home.

Although none of our results can be considered sufficient to justify the belief which we hold that yellow fever no longer maintains an endemic persistence in Freetown, the following points taken cumulatively appear to support that conclusion, in addition to what is stated above: —

(1) There is no complete segregation of whites, many of whom live in quarters side by side with houses occupied by natives of the town. Yet one does not constantly have cases suspicious of yellow fever now. Mosquito nets are, however, in general use, and the compounds of the Europeans are under the same supervision as those of the natives.

(2) Even if there exists in natives some degree of immunity, we know that serious and fatal cases do occur in epidemics. Four cases occurred in natives in the 1910 epidemic, two of them fatal. Thus if during the inter-epidemic period the disease exists in the form of a succession of mild cases, one should expect an occasional case sufficiently severe to attract the notice of investigators especially on the look-out for such cases. Yet we have found no case in a native which could be regarded as even a mild case of yellow fever, typical or atypical.

(3) We have no indication that at present the Syrians, soon after arrival, suffer inordinately from malignant fevers not attributable to malaria (vide under heading 'Nationality' above). In 1910, the year of the last yellow fever outbreak, the Syrians numbered 72, and occupied 55 premises. In 1911, the number of Syrians was 145 (as this was the Government census the number probably includes

* Appendix E

several passing through and not resident). At the present time (Medical Report for 1913) they number 212, living in 110 premises, and including 25 children. As a matter of fact in Freetown their compounds are visited, and *Stegomyia* kept down.

(4) The blood of children—93 examined under five years, besides others—has yielded no case of *Paraplasmosis* during our research. The *Paraplasma flavigenum* is much more difficult to detect than *Plasmodium* or *Laverania Malariae* so commonly present; but allowing for this we are unable to assert that the use of the microscope during the past six months has afforded any evidence at all that there exists a corresponding infection of young people with the parasite of yellow fever.

(5) No case has come before us which the natives recognised as 'Bayloo.'

(6) If during the interval after the epidemic of 1910, yellow fever has been and still is transmitted in successive generations by *Stegomyia*, it is possible that the lower animals may act as host, and perhaps be gradually evolving a mild yet protective strain, vaccinia-like, amongst those most exposed to mosquito bites. Our examination of dog's blood has shown nothing resembling *Paraplasma*, but the number, 42, is not great. Possibly in the presence of a recognisable outbreak of yellow fever the chances of finding such bodies might be increased, and their occurrence under any circumstances would have an important bearing on the endemic maintenance of the disease. Workers in Lagos found bodies resembling *Paraplasma* in two dogs naturally infected.

(7) The supply of *Stegomyia* does not seem to meet the demand required for a 'yellow fever level' (see Table 7, etc.). A fallacy exists here, however, in the presence of wells, which are not included in the estimation of the Larva Index, and which have been separately shown to be a factor by no means negligible. Moreover, *Stegomyia* wells were obviously grouped in definable areas in the town where that mosquito may well have been the prevailing species even if scarce in other quarters. An 'Adult Mosquito Census' might reveal a preponderance of *Stegomyia* above that suggested by the Larva Index on its present lines.

In considering the sudden appearance of a case of yellow fever from an up-country station it is allowable to suppose that anti-

mosquito campaigns and a pipe-borne water supply might have made yellow fever transmission unlikely in large sea-board towns, while inland stations, many of them equally infested with *Stegomyia*, or other coast towns living in happy freedom from such a thorn in the flesh as a Sanitary Department, might still be expected to yield cases. The locality from which the present case of yellow fever was derived has been visited by Dr. Johnson; notes of his visit are appended (Appendix C.); but as no mosquitoes were found and no indication of any other cases of fever transpired, the source of infection is still unexplained. The death of the patient's pet monkey a week after the first symptoms in its master, however tempting to the imagination, can hardly be regarded as a clue when unsupported by other more satisfactory evidence!

11. *Suggestions for future research*

1. We have thought that a small town on the coast, or near it in the estuary of one of the rivers in the Colony, might form a suitable locality for a few months' research. Bonthe was suggested as worth a visit, and has been reported on, but there would seem to be a distinct advantage in selecting a spot where European supervision of sanitation is practically absent, where at the same time a certain number of non-immunes such as Syrians are resident, and which, being in touch both with native coast shipping and inland traffic, might be exposed to infection and likely to maintain it. Dr. Johnson's report (see Appendix B.) on his visit to some of the nearer towns is in favour of Kambia as a suitable centre. At the same time, as an example of an inland town at some distance, but containing both a number of Europeans and a garrison of native soldiers with their families, Daru has been suggested, but there has not yet been an opportunity to pay a visit there. The actual demonstration of an endemic focus in the Sierra Leone hinterland would be of exceptional interest.

2. It is possible that one really important endemic focus in West Africa is not any particular sea-port, but may conceivably be found in the holds of merchant ships. It is satisfactory to know that a medical officer is about to commence an inspection of ships for Stegomyia, and to collect information as to their prevalence in holds and fo'c'sles.

3. It was thought that experimental work might be done on the lines of the deviation of complement tests. Dr. Seidelin reports negative results in the few cases to which he applied this method of investigation (*Y.F. Bur. Bull.*, Vol. 2, No. 2, Oct. 1912, p. 195), but he experimented only with cases in the acute stage or early in convalescence, and it is recognised that complement fixation is a late manifestation. Our intention was to experiment with antigens prepared from yellow fever liver and other organs from cases of yellow fever, and to test these against the sera of patients known to have had yellow fever previously and also against the sera of native and Syrian children, and other cases after recovery from mild pyrexial attacks. In this way, had the test been successful, some information might have been obtained as to inherited and acquired immunity amongst native races.

In preparation for this work a sheep-rabbit amboceptor was obtained weekly from home through the Commission and a series of Wassermann tests (Stern modification) were made on known and doubtful syphilitic cases, using the ordinary myocardial extract as syphilitic antigen, and employing throughout the technique followed by Major Harrison, R.A.M.C., at the Rochester Row Hospital. These tests proved absolutely reliable in a large number of syphilitic cases, and it was unfortunate that the work had to be abandoned owing to our failure to obtain material to be used for the yellow fever antigens. Incidentally, whilst waiting for material, a series of experiments were made upon complement fixation occurring in helminthic infections.

4. In addition to clinical and laboratory methods there may still be scope for the use of precise methods in the study of epidemiology, and by careful study of the source of each outbreak to determine at length the degree to which a community is an endemic focus. The occurrence of repeated outbreaks of yellow fever in conjunction with periodic immigration of non-immunes could hardly be explained in any other way than as an index of endemicity, if imported cases could be excluded with any certainty—a work of some difficulty. But imported cases may be responsible for the notoriety attached to some ports for being in a chronic focus. In the recorded epidemic of Freetown of 1910 the history and period of residence of the earliest cases—at first overlooked—could not be ascertained, so that it is

impossible to affirm that the Syrians first attacked were the victims of an endemic haunt, though the state of Freetown at that date renders this quite likely. Nothing can be proved either way, but it is equally likely that the outbreak may have originated from an imported case. In the present state of the town this explanation would be much more likely, and in Freetown the danger of importation is not entirely confined to sea-borne cases, but may also arise through the railway from the landward side.

This idea receives support from the fact that our only case of yellow fever was brought to Freetown from an up-station. An early investigation of the local circumstances was set on foot, but nothing definite to explain the infection was found, and no other suspicious cases could be traced. Mosquitoes are difficult to find at this time of year, and the patient was not received nor the diagnosis clear until several days after the commencement of his illness.

In the instance of Grand Bassam when 'three cases occurred amongst natives in October, 1910' (*Y. F. Bur. Bull.*, No. 1, May, 1911), the outbreak was attributed, rightly or not, to a native who arrived from Freetown where the epidemic had existed from May to September. We have not heard of any later instance of this nature which would justify the suspicion of yellow fever being endemic in Freetown during the interval.

The investigations of Sir Rubert Boyce certainly seemed to prove the endemicity of yellow fever in Freetown from a period dating back at least to 1815, and the probable existence of some degree of immunity acquired by the local natives. Opinions may differ, however, as to the extent of that endemicity in more recent times, and on the question whether it has continued right up to the outbreak of 1910, or whether it suffered a first serious check with the abolition of the slave-ships.

Anti-stegomyia measures during the past two or three years are, we cannot doubt, altering the acquired resistance of the native to a state of protection from attack. This is an immunity in an endemiological sense, and if these practical measures are as efficiently maintained in future as at present, the fact that the natives are progressively losing their biological immunity is a matter rather for academic discussion than local concern, for endemicity without the mosquito is like Hamlet without the Prince.

In conclusion, we wish to tender our thanks to Dr. Rice, Principal Medical Officer, for his ever-ready assistance and sympathy with our work, and to Dr. Young, Medical Officer, for his help in our laboratory work. Our thanks are also due to Dr. Kennan, Senior Sanitary Officer, who has made us many valuable suggestions, and to Dr. Orpen, Medical Officer of Health, for his assistance in obtaining statistics as to anti-mosquito measures and sanitation in Freetown.

Attached will be found:—

Appendix A.—Notes on four cases of Jaundice.
Appendix B.—Report on visit to Kambia District.
Appendix C.—Report on visit to Boia.
Appendix D.—Full notes on European case of Yellow Fever.
Appendix E.—Notes on cases of possible Paraplasmosis.

Appendix A

Notes on Four Cases of Jaundice

Case No. 97

School-girl, age 12, Sierra Leonian.

Dispensary out-patient, 14th October, 1913, and not seen again.

Complained of fever with jaundice for about six days, and called it 'Yellow Fever.'

Distinct icterus of sclerotics present; no headache nor backache; no vomiting, but some epigastric tenderness; bowels free; coryza present for two days.

Liver distinctly enlarged; spleen not palpable. Quinine not given. Temperature 98·6°, pulse 72.

Urine—distinct cloud of albumen, no casts.

Blood examination—no malaria parasites found.

Differential leucocyte count:—

Polymorphs.	34·5%
Lymphocytes	55·3%
Large Monos. and Trans.	7·6%
Eosinophils	2·6% (350 cells)

Diagnosis.—Catarrhal Jaundice.

In this case the patient's attack had subsided on the day she attended the dispensary, and her temperature was normal, though jaundice was still present. N.B.—A comparatively late appearance of jaundice during convalescence of a mild case would raise the suspicion of yellow fever. In the present case the data are scanty, but the information, such as it is, suggests that jaundice was an early symptom.

This case may be regarded as typical of what the Sierra Leone native calls 'Yellow Fever,' which may be anything from a simple bilious attack, or even a coryza with slight rise in temperature and consequent concentration and darkening in the colour of the urine, to a serious obstructive jaundice due to organic disease, or on the other hand to the justly dreaded yellow fever.

Case No. 277

School teacher, age 27, Sierra Leonian.

Dispensary out-patient, 9th December, 1913—refused to come into hospital.

Suffering from fever since 24th November, 1913—sixteen days—continuous, but worse in evenings; much weakness and loss of appetite; off work for two weeks. History of vomiting yellow or green fluid at commencement of attack on November 24th-26th, but no black vomit. Headache and pain in limbs, but no backache. Yellow tint of sclerotics distinct. Bowels free after purge; tongue furred and fissured. Temperature 98·6°, pulse 96.

Blood examination—no malaria parasites seen.

Differential leucocyte count:—

Polymorphs.	67·5%
Lymphocytes	21·2%
Large Monos. and Trans.	5·5%
Eosinophils	5·8% (400 cells)

Thick film—no parasites

Urine—albumen present, no casts, no glycosuria.

Diagnosis.—Pyrexia of uncertain origin.

This case did not attend until the sixteenth day of his illness, and only attended once. It is an example of the comparative uselessness of the out-patient from the investigator's point of view. The significance of albumen in the urine in native patients is rather doubtful. Dr. Butler and Dr. Young found during their routine work at Freetown that albumen—but no casts—seems to appear during pyrexia of almost any origin and however mild, and this has also been our experience.

Case No. 382

Seaman, age 34, Sierra Leonian.

Admitted to hospital 27th January, 1914.

Complained of fever and jaundice for one week, with vomiting and epigastric tenderness; fever worse at night.

Patient was obviously very ill; intensely jaundiced. No history of dysentery. In the right hypochondrium a swelling (? gall-bladder) could be felt, and was said to have been present for three months.

Temperature on admission 97·6°, pulse 100.

Blood examination—no parasites found.

Leucocytosis apparent; a few nucleated red cells.

Differential count:—

Polymorphs.	86·7%
Lymphocytes	8·3%
Large Monos.	3·3%
Eosinophils	1·7% (450 cells)

Urine—albumen abundant, bile present, numerous granular and a few epithelial casts.

Faeces—no ova, etc.

Temperature remained subnormal until death on the fourth day after admission, when it was 99°.

Post-mortem.—' Pancreatic tumour obstructing common bile duct.' (P.-m. performed by the Medical Officer in charge of case)

Diagnosis.—Obstructive Jaundice.

Case No. 432

Seaman, age 24, native of Calabar.

Admitted to hospital on 4th March, 1914.

Complains of fever for one week with cough and vomiting. Calls it 'Yellow Fever.' Backache and pain in chest; distinct jaundice (could not state date of appearance); vomit bilious; epigastric tenderness; tongue thickly furred; bowels confined.

Pleuritic rub over right side of chest; cough with bile-stained sputum. Has a septic ulcer on leg.

Temperature on admission (sixth day of illness) 100°. On the following day rose to 103° at noon, falling to 100° in the evening. On the eight day (a.m.) rose to 102°, falling to 98° in evening. On ninth day morning temperature 100°, evening subnormal. Remained subnormal until discharge on twelfth day.

Pulse 110. No Faget's sign.

Urine—s.g. 1010; deeply bile-stained; albumen abundant; no casts. Albumen cleared up in a few days.

Faeces—ova of *Trichocephalus trichiuris* present.

Blood examination—no malaria parasites.

Leucocytosis present.

Differential count:—

Polymorphs.	83·0%
Lymphocytes	9·0%
Large Monos. and Trans.	7·5%
Eosinophils	0·2%
Mast cells	0·3% (350 cells)

Recovery, but still jaundiced on discharge from hospital.

Diagnosis.—'*Hepatitis with Pleurisy.*'

Appendix B

Visit to Port Lokkoh, Kambia, etc.

Contents of Report:

1. *Introduction*

In the hope of finding some place in which a local investigator on the Yellow Fever Commission could find useful clinical material for a prolonged study of the fevers occurring in native towns outside the influence of direct European sanitary control, a tour was made in the Karene district with a view to ascertaining the conditions of large native towns, in communication with the coast, in which no sanitary staff under the control of Europeans exists.

The most important towns visited, Port Lokkoh, Mange, and Kambia, were suggested to us by the Principal Medical Officer and Senior Sanitary Officer of Sierra Leone as being likely to contain many *Stegomyia* mosquitoes, and also as having a large non-native population.

Port Lokkoh is situated at the end of the Lokkoh creek from the 'Sierra Leone River'; Mange is on the Little Scarcies River; and Kambia is on the Great Scarcies River. All of these places are in constant communication with Freetown and other coast towns by means of native boats. It was intended to extend the tour to Bassia, further up the Great Scarcies River, but I was recalled to Freetown, and so had to omit visiting this large native town.

The Principal Medical Officer very kindly supplied me with necessary drugs and instruments, so that I was able to announce my intention of treating any case of sickness in any town and village in which I stayed, and accordingly during my tour I saw a large number of patients, and had an excellent opportunity of ascertaining the occurrence of any prevalent fevers.

In this report I am confining my remarks on the sanitary condition of the towns visited to those conditions affecting the possible occurrence of yellow fever and allied fevers.

2. *Itinerary of Tour*

I left Freetown on March 2nd, and arrived on the same day at Port Lokkoh, where I stayed until March 6th. I spent from March 6th to March 9th in visiting villages situated in a large tract of marshy land lying to the N.W. of the main Lokkoh-Mange road, passing nights at Moiyombu, Mangara, and Manyatu. Intending to visit Mange on my return journey, I spent only one night in that

town, and so reached Kambia on March 10th. Leaving Kambia on March 15th, and Mange on March 16th, I returned to Freetown on March 17th, after an absence of 16 days.

3. *Port Lokkoh*

(*a*) *Description.* Port Lokkoh is situated on high ground at the end of the Lokkoh creek. It is a town of about 4,000 inhabitants, including nearly 1,000 Creoles* and Syrians. The native population is mostly Timnee.

At some distance from the town are barracks for a company of troops, and mud houses for five or six European officers. A Royal Army Medical Corps officer is in medical charge of this section. In the town itself are only three white men—the Assistant District Commissioner and two Europeans in charge of a trading firm.

(*b*) *Sanitary condition.* The houses are built of mud with grass and palm roofs, and the compounds are dirty and littered with tins and refuse of all kinds, but at this time of year none of these empty tins and bottles contain water. The sanitation about the District Commissioner's quarters and the rest house is undertaken by a sanitary staff of four men, who are, of course, quite unable to deal with the town at large. The streets are kept clean and clear of refuse by the native chief. Borrow pits are scattered all over the town.

The water supply is taken for the most part from two rapidly running streams which intersect the town, but a few uncovered wells also exist. Water is stored in native pots and tins about the houses, but usually the water is changed daily, and the larval index at this time of year is not high.

(*c*) *Blood-sucking Diptera at Lokkoh.* At this time of year mosquitoes are not a pest at Lokkoh. An attempt was made to work out the larval index of the town, but as it was impossible to visit every house in the short time available an incomplete index was calculated by visiting one house in every five of the 200 houses in the central part of the town, with the following results:—

Houses visited	40
Water receptacles holding water	101
Houses in which *Stegomyia* larvae found	3
Houses in which other Culicine larvae found	3
Total Larval index	15·0
Stegomyia index	7·5

* For the significance of the word 'Creole' as used by Lieutenant-Colonel Statham, Dr. Butler, Dr. Dalziel and Dr. Johnson in their reports, *vide* Lieutenant-Colonel Statham's report, page 356 *supra*.

Details as below :—

(1) Marshy pool in compound by well ...	*Anopheles costalis*
(2) Water barrel	*Stegomyia fasciata*
(3) Water barrel	*Culex consimilis*
	Culex decens
(4) Large native water-pot	*Anopheles costalis*
(5) Old paint tin	*Stegomyia fasciata*
	Culiciomyia (? sp.)
(6) Calabash	*Stegomyia fasciata*

No larvae were found in three wells examined.

Larvae were found in pools by the banks of the two streams supplying the town with water :—

Anopheles costalis.
Anopheles (*Myz.*) *funestus.*
Culex decens.
Culex tigripes (single specimen).

Other blood-sucking Diptera caught :—

Culicoides (? sp.). Scanty.
Glossina palpalis—common on the creek below Lokkoh.

(*d*) *Clinical work.* A native dispenser in charge of the Government Dispensary at Port Lokkoh treats a fair number of patients daily, but the majority of the Syrian population prefer to obtain treatment from a local druggist or from a trader in patent medicines.

The Chief promised to inform me of cases of sickness in the town, but he states that all serious cases of illness are sent out of the town into the bush.

Looking over the case-book at the dispensary, I found that 259 patients had been treated since the beginning of the year, only five of which had been diagnosed as 'fever.' Of course, no blood examination had been made. One case, now quite well, was said to have had jaundice with fever, but the dispenser asserts that cases of jaundice are most uncommon, and he knows of no disease corresponding to the description of 'Bayloo' as occurring at Lokkoh.

During my sojourn in this town I examined the bloods of seven patients who complained of fever. Five of these cases showed subtertian parasites, one showed quartan parasites, and the other appeared to be merely a case of constipation. I also treated 18 non-febrile cases.

Capt. Lewis, R.A.M.C., kindly promised me notes and blood smears from any cases of fever coming under his observation during my tour, but no cases occurred.

(*e*) *Splenic Index at Port Lokkoh.* This was worked out from children between the ages of 8 and 15 years at the two mission schools:

Number of children examined	110
Spleen over 2 inches below costal margin	24
Spleen palpable	61 = 85

Splenic index = 77·3

This figure differs remarkably from that obtained in June, 1913, by the Medical Officer on patrol, who found it at that time to be only 46·2 in 110 children.

4. *District between Lokkoh and Mange*

The first village visited, Moiyombu, is about two hours from Lokkoh, and is situated at the edge of a large area of swampy land, and on higher land amidst this swamp are placed the two other villages at which I stayed—Mangara and Manyatu.

The villages are small and contain no rest houses. Mosquitoes abound, and after dusk they swarm in such numbers that the traveller is speedily driven to shelter beneath his net. The type found was almost exclusively *Mansonioides uniformis*, but a few specimens of *Anopheles costalis* and *Culiciomyia nebulosa* were also obtained.

Water is obtained from muddy pools and is not stored about the huts; I found no *Stegomyia* mosquitoes.

Many patients came for treatment, nearly all complaining of bronchitis, rheumatism, or some surgical affection. I saw only one case of fever—a child aged 2 years with pertussis, who showed numerous subtertian parasites on blood examination.

5. *Mange*

My recall to Freetown prevented me from staying at Mange on my return journey as I had intended, so that I obtained very little information about this town. It is a town with roughly 3,000 native inhabitants and about 50 Syrians. It is built on rising ground at some little distance from the banks of the Little Scarcies River, a low tract of land, swampy in the rains, intervening between the river and the town. Deep valleys with marshy stream beds lie on either side of the town, and from these clouds of mosquitoes enter Mange, and become a pest after dusk. The type of mosquito caught in the rest house during my visit was exclusively *Mansonioides uniformis*.

The town is more dirty than the average of native towns, and

it was unfortunate that I had no opportunity to work out the *Stegomyia* index.

I saw only seven patients at Mange, as I left before daybreak, and these included no cases of fever.

6. *Kambia*

(*a*) *Description.* Kambia is a native town of about 2,500 inhabitants, the majority of whom are Timnee and Susu, but there are also about 40 or 50 Syrians and a fair number of Creoles.

It is built on high ground sloping to the Great Scarcies River, and thus has an excellent natural drainage. Native boats bring it into constant relation with Freetown, which is reached with favourable winds in from two to three days.

(*b*) *Sanitary condition.* The huts are mostly well built, and the town is considerably cleaner than Lokkoh or Mange, probably owing to the intelligence of the Chief, who does his best to keep it in a sanitary condition, but tins and bottles still form an integral part of most of the compounds, and borrow pits exist all over the town.

The water supply is taken partly from deep wells, but mostly from the Scarcies River as it runs in rapids over the great barrier of rock which prevents navigation of the river above Kambia. There are also a few shallow wells and water-holes in the vegetable gardens situated between the town and the river. Water is stored about the houses in native water-pots, but these are mostly quite small and the water is changed daily.

(*c*) *Blood-sucking Diptera at Kambia.* At this time of year the water mosquitoes are not prevalent within the town. *Mansonioides uniformis* is common by the banks of the river above Kambia. I examined every third house in the town in order to calculate the larval index, with the following results:—

Houses visited	70	
Receptacles holding water ...	128	
Stegomyia larvae found ...	1	(In an old kerosene tin containing native medicine.)

Stegomyia index = 1·4

Eleven wells were examined—seven shallow wells in the vegetable gardens already mentioned, and four deep drinking-water wells. In the seven shallow wells *Anopheles* (*Myz.*) *funestus* larvae were found in three, and *Culex* (? *sp.*—failed to hatch out) in two. In the deep wells larvae of *Culiciomyia nebulosa* were found in three.

A *Culicoides* (? sp.) occurs near the river banks, and *Glossina palpalis* occurs in swarms on the reaches of the river above Kambia, though I saw only one specimen in the town itself.

(*d*) *Clinical Work.* I commenced operations upon my arrival at Kambia by tapping a large hydrocele for the Chief, and by interviewing the chief Syrian trader in the town, and treating him for dysentery. On the following days, 49, 62, 77, and 83 new cases from Kambia and the surrounding villages attended for treatment, so that it would appear that any investigator intending to work at Kambia would have no difficulty in obtaining clinical material; but it is obvious that a number of patients come only from curiosity to taste the white man's medicine, or from the inherent love which a native seems to possess for a liniment and for an efficient purge. The Principal Medical Officer had most kindly put at my disposal the services of the dispenser from Lokkoh, without whom I should have been quite unable to cope with the work.

The Chief declares that fever is common at this time of year, but is not common during the rains, but on closer questioning it appears that the 'fever' is 'fever with cough' and indeed bronchitis, pleurisy, and a mild bronchial catarrh are common ailments in this district. The most common ailment is dyspepsia, doubtless due to the fact that cassada forms the staple article of diet, a quantity of which is eaten raw. Other common complaints are chronic rheumatism, and various surgical affections—stricture, hernia, hydrocele, elephantiasis, and parotid tumour. Syphilis appears to be very common, and I saw several cases of congenital syphilis with marasmus in infants. It is likely that congenital syphilis is a potent factor in infant mortality, at least in this district.

I could obtain no information of any diseases attended with jaundice or answering to the description of 'Bayloo.'

Of the 271 cases which I treated at Kambia I saw necessity for making only 11 blood examinations, with the following diagnoses:—

Subtertian Malaria	5	
Quartan Malaria	3	
Probably Malaria ...	1	(Pigmented leucocytes and high mononuclear count.)
Non-malarial	2	(One had scanty subtertian parasites, but both cases appeared to be merely dyspepsia.)

I saw 10 non-natives (Syrians) of whom 3 were suffering from malaria.

(*e*) *Splenic Index at Kambia.* I was too busy to make a complete index throughout the town, so had to confine my attention to the children at the one mission school. The numbers are too few to be of value:—

Number of children examined	25	
Spleen over 2 inches below costal margin	4	
Spleen papable	15	= 19

Splenic index = 76·0

7. *Summary*

(1) I found no evidence of fevers other than malaria in the places in which I stayed, but the whole tour extended over only 16 days, and only about 300 cases of sickness were seen.

(2) The splenic index of children under 15 years of age was high both at Lokkoh and at Kambia.

(3) The natives welcome the presence of a white doctor, and readily come for treatment.

(4) The *Stegomyia* index was low (7·5 at Lokkoh and 1·4 at Kambia), but both these towns have most favourable conditions for the breeding of *Stegomyia*, which are probably very numerous in the rains and early in the dry season.

8. *Recommendations*

Taking into consideration the confidence shown by both natives and non-natives in a white doctor, the fact that ideal conditions are present for *Stegomyia* breeding, and that free communication exists with Freetown and other coast places, Kambia would appear to be an excellent place for a local investigator to study fevers of the country, especially as regards mild yellow fever occurring in natives.

Kambia, from its position between the two large towns of Mange and Bassia, and its comparatively large non-native population, would be the best centre of any of the places described in this report for an investigator to make his head-quarters.

In order to obtain clinical material for the study of fever cases it would be necessary to treat any cases coming for advice, and it

would be especially necessary to be prepared to treat surgical cases —otherwise the confidence of the natives would be soon lost

To treat cases successfully it would be necessary to have some building capable of being used as a hospital, equipped with a few of the drugs in most common use and with a few surgical instruments. A mud house for this purpose could easily be built at small expense at the outskirts of the town.

A dispenser, or at least a native dresser, who could talk Timnee would be indispensable.

I believe that a town such as Kambia would furnish clinical material of much greater value for the purposes of the Commission than any town along the coast to which European civilisation and sanitary methods have spread.

A particularly interesting study could be made of the fevers attacking children of the Syrian population of these towns—cases of which one has found by experience that an investigator in Freetown sees little or nothing.

W. B. J.

Appendix C

Visit to Boia and Moyamba

On Friday, March 13th, a case was sent from Boia, a station on the Sierra Leone Government Railway, to Freetown, where it was diagnosed as yellow fever, on Monday, March 16th. On Tuesday, March 17th, Dr. Kennan, Senior Sanitary Officer, and Dr. Clarke, Medical Officer, proceeded to Boia, and on the following day, on my arrival at Freetown from my tour of the Kambia district, I went to the same place. I stayed at Boia until March 24th (i.e., until 15 days had elapsed from the onset of our patient's illness), and after a visit to Moyamba, 12 miles distant, I returned to Freetown on March 26th.

Boia is about 60 miles from Freetown at the junction of the main line with the branch line to Makump. The place consists of five bungalows for Europeans, a mud-built rest house, and a reservation for railway employees and labourers. The European staff consists of two first-class officials, a fitter, a foreman platelayer, and a varying number of engine-drivers—usually four are stationed at Boia, but these men are constantly changing.

The bush has been cleared for a considerable distance from the bungalows. That in which the case of yellow fever occurred was a double bungalow for the accommodation of the fitter and foreman platelayer. It had been sealed and fumigated by Dr. Kennan before my arrival. The house nearest to this was also fumigated. The mosquito nets in both these houses were in holes and quite unfit for use.

With one exception each house has a rain-water tank, three of which had become imperfectly mosquito-proofed. These tanks had been sealed before my arrival, for although the rain-water is exhausted, a small amount accumulates each day from the dew dripping from the roofs. The drinking-water supply for these bungalows is brought daily by trolley from a stream above the reservoir, which is placed amongst the hills at over a mile from the station and from which a pipe-borne water-supply is constructed, but not yet in use. No culicine larvae were found about the European houses.

The native reservation is placed at about 800 yards from the nearest European bungalow. It had been recently cleaned up and was quite free from refuse. I visited with Dr. Kennan 25 houses and compounds on the day of my arrival, and we found no culicine larvae, but there were 10 barrels containing water, the screens for which had been lost or destroyed. The water supply for this part will eventually come from the reservoir, but at present it is carried from a stream in the valley below the railway. This stream is of rapidly running water, and is well stocked with small fish; it is difficult to demonstrate larvae in it, but a few anopheline larvae were found after patient dipping.

Behind the reservation is a collection of huts built originally as temporary shelters, but now walled in with mud. Unfortunately a gin-shop has been allowed here also, with the result that the ground about the huts is thickly strewn with empty bottles. No attempt has been made to clear the bush around these huts. However, no large water receptacles exist, and no larvae were found. There are no wells.

Visits were made to the villages within easy reach of Boia station. There are only two of any size, and these—Boia and Tungea—are both about 1½ miles from the station. They are both dirty, and

afford numberless opportunities for *Stegomyia* breeding during the rains, but at this time of year I failed to discover a single culicine larva.

During the whole period of my visit to Boia I did not see a mosquito of any kind, and the only blood-sucking Diptera obtained were a few specimens of a *Culicoides* (? *sp.*) and a single specimen of *Tabanus kingsleyi* (Ricardo).

Clinical work. Our first attention was directed towards the contacts with the infected case. These consisted of the Europeans in the station and the labourers who had been under the patient's control, besides his personal servant who had gone with him to Freetown where he was kept under observation. No symptoms or indisposition of any kind arose amongst the Europeans or labourers during my visit, and, in view of the absence of mosquito carriers in the place, no more detailed examination of contacts was considered necessary.

The chiefs of the surrounding villages were interviewed, and asked to send in any cases of illness which occurred. Dr. Clarke and myself saw 32 cases from this source, but these included no cases of any febrile complaint.

My visit to Boia has thus been of entirely negative value, and has not explained in any way the source from which the patient became infected. It is apparently quite certain that he has not spent a night away from Boia, at least for some months, and his duties do not carry him up or down the line for any distance. One is, therefore, almost forced to conclude that the infective mosquito must have been introduced from a distance, and there seems to be no possibility of an epidemic of yellow fever occurring in the Boia neighbourhood.

Moyamba

Two days were spent in the visit to Moyamba which is the only native town of any size in the neighbourhood. It is 12 miles up the line from Boia, and consists of two European houses besides a large rest house and a native town of about 1,000 inhabitants.

I found Dr. Wood-Mason, the Medical Officer, about to take a

larval index of the native town, so I seized the opportunity of doing it with him. We obtained the following results:—

Compounds visited	23	(These include nearly all the huts in the town, as there are few huts with separate compounds.)
Receptacles holding water :—		
Barrels	2	
Native pots	2	
Tin basins	9	
Kerosene tins	3	
	16	
Receptacles capable of holding water :—		
Tins	335	
Bottles	834	
Pots	8	

No larvae were found. The empty tins and bottles were found almost exclusively in the Creole parts of the town.

It will be seen that Moyamba would be a favourable place for mosquito breeding during the rainy season—especially for *Stegomyia*—but it is hoped that the energies of the sanitary gang will induce a better state of affairs before the onset of the rains.

W. B. J.

Appendix D

Notes on European Case of Yellow Fever

(See page 545)

Male, aged 32.

Sent to Freetown from Boia, and admitted to the Nursing Home on Friday, 13th March, 1914.

Temperature on admission 102·6°, pulse 68, respirations 24.

History.—On *Monday, 9th March*, 1914, felt feverish, malaise, etc., but at work.

On *Tuesday, 10th March*, 1914, attempted work but returned and went to bed; vomited freely, and nausea and vomiting have persisted since. Patient thinks that his vomit was black almost from the first, but this is uncertain; he has apparently had *epistaxis* from an early date in his illness. The same evening Dr. Wood-Mason was sent for from Moyamba, and recorded temperature 99·4°, pulse 90, vomiting, headache intense and epigastric pain. Spleen palpable and tender, no pain nor tenderness in right iliac fossa, and no muscular rigidity.

Diaphoretic mixture, and quinine, grs. 5 thrice daily ordered, and a mustard poultice to epigastrium. Temperature on Tuesday morning, 10th March, 1914, is stated to have been 103°.

Wednesday, 11th March, 1914.—Morning temperature was reported by wire to be 101°.

Thursday evening, 12th March, 1914.—Temperature 104° (morning temperature not reported). Tepid bath and sponging recommended.

Friday, 13th March, 1914.—Temperature, 9 a.m., 101·6°. Pulse 76. Dr. Wood-Mason saw him. Vomiting, but not much pain, tongue moist and slightly furred. Spleen not palpable nor tender; bowels opened. On arrival in hospital, Freetown, temperature 102·6°, pulse 68, headache severe, nausea and retching; quinine bihydrochloride, grs. 10, given, but vomited. Slept one hour at night; next morning given quinine bihydrochloride and retained it.

Saturday, 14th March, 1914.—Jaundice was not apparent, but the conjunctivae were distinctly suffused. Some mental confusion noticed; headache severe and pain in back, but not in limbs nor in epigastrium. Vomits frequently, no black material. Takes only barley water and Perrier water. Tongue coated in centre, red at edges; no soreness or red line on gums.

Urine.—Albumen abundant, no bile detected, but granular casts stained yellow were found.

Mist. ammon. acetat. and bismuth prescribed. Temperature fell to 101°, headache improved; patient slept a little during the day.

Blood smear.—No malaria parasites found, no other parasites.

Sunday, 15th March, 1914.—Slept fairly well. No pain except slight headache; dull of hearing, and speech not quite clear; no vomiting, but great thirst. Temperature keeps about 101°, pulse 60-70; temperature fell to 100° in evening. During the night intense headache relieved by epistaxis.

Urine, 15th March, 1914.—Amount, 42 ozs. Albumen 0·2 per cent. (Esbach). No bile detected; casts as before.

Blood examination.—No parasites. Total red cells 6,480,000, a few nucleated reds. Haemoglobin 85 per cent. Total whites 5,156. Differential count:—

Polymorphs	68·0%
Lymphocytes	23·2%
Large Monos.	8·5%
Eosinophils	0·3%

Monday, 16th March, 1914.—Eyes more suffused and icterus of sclerotics now distinct. Temperature 101°. Pulse 72. Patient feels well and wishes to get up. Simple enema given to relieve bowels. Mixture of bismuth stopped and liq. hydrarg. perchlor. and sod. bicarb. given. Milk diet and barley water. Seen by Principal Medical Officer and Senior Sanitary Officer and diagnosed as *Yellow Fever.*

Urine, 16th March, 1914.—Albumen as before, bile distinct, casts as before.

Tuesday, 17th March, 1914.—Temperature 101°, pulse 64.

Urine.—60 ozs., albumen and bile as before. Jaundice slightly increased.

Wednesday, 18th March, 1914.—Temperature 100°, pulse 54, epistaxis continues, vomiting less; feels well but can take only barley water. Black stool passed.

Urine.—Albumen, bile, etc., as before. Amount, 48 ozs.

Thursday, 19th March, 1914.—Temperature 99°, pulse 54. Jaundice as before.

Urine.—Albumen still 0·2 per cent., bile abundant, casts present but few. Epistaxis and vomiting less. Urine amount, 44 ozs.

Friday, 20th March, 1914.—Temperature normal, pulse 50. Jaundice still present, but no flush of eyes.

Urine.—Albumen 0·1 per cent., bile as before. Feels well, takes Benger's food and toast. Urine amount, 45 ozs.

Saturday, 21st March, 1914.—Icterus slightly less, but yellow tint of body observable, especially about ankles, etc.

Urine.—Albumen 0·07 per cent., bile distinctly less, casts present, but few.

Sunday, 22nd March, 1914.—Temperature 98·8°, pulse 48. Feels well.

Monday, 23rd March, 1914.—Temperature normal, pulse 54. Icterus less, but still on the limbs.

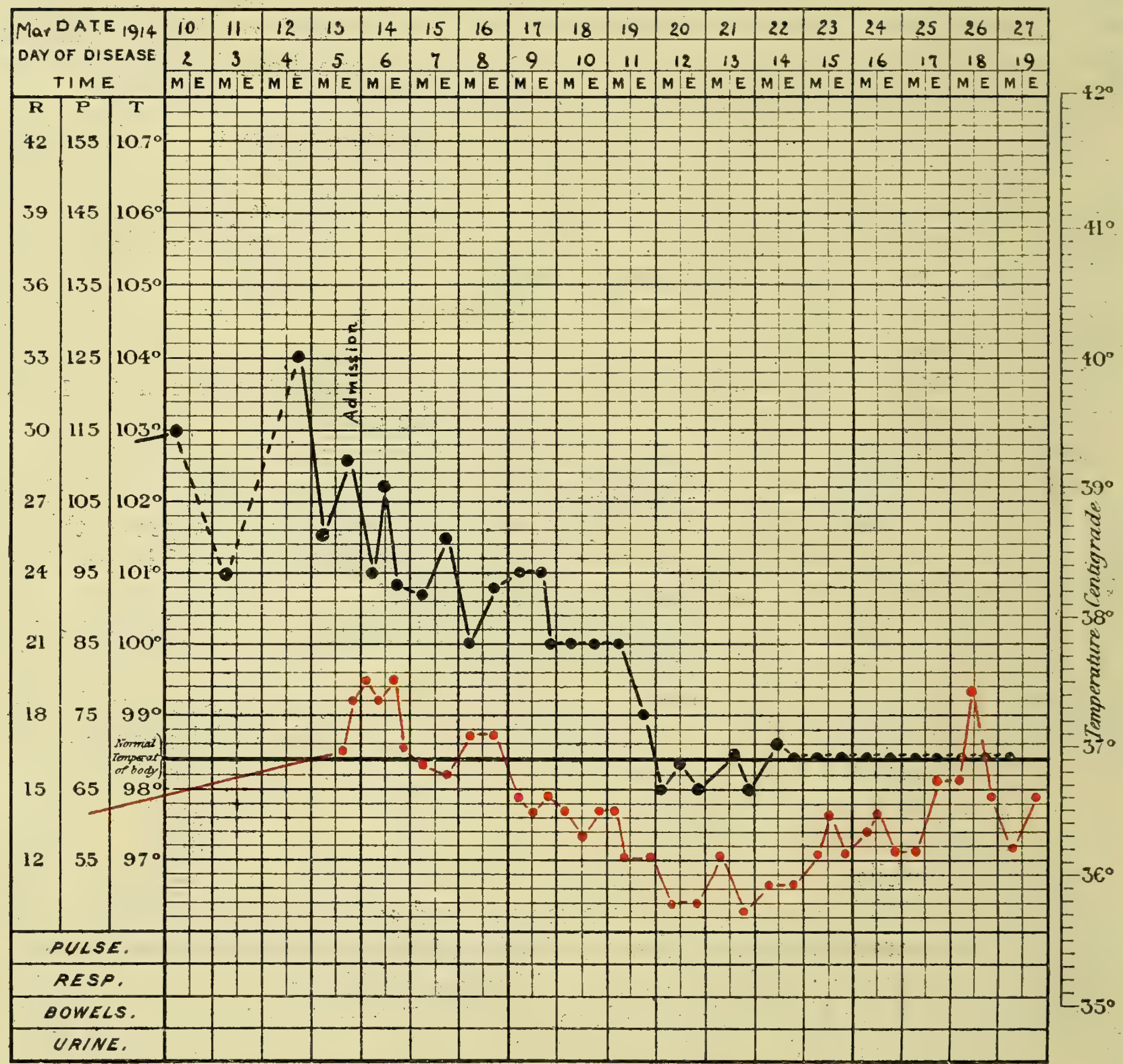

Chart 1

Urine.—Albumen 0·02 per cent., bile diminished, 60 ozs.

Thursday, 24th March, 1914.—Patient got up for an hour.

Urine.—Albumen slight cloud, bile slight, still a few yellow granular casts.

Wednesday, 25th March, 1914.—Patient up, yellow tint fading from limbs. Temperature normal, pulse 60.

Urine.—Mere trace of albumen and bile; a few casts still present.

Friday, 27th March, 1914.—Temperature 98°, pulse 64.

Urine.—Free from albumen and bile, and no casts found.

Diagnosis.—*Yellow Fever.*

Notes.—This patient was in his third tour of service in Sierra Leone. He was said to have been in the habit of taking 5 grs. of quinine daily. He had had dysentery in Chili some years ago.

In May, 1912, he was admitted to the Nursing Home at Freetown and underwent an operation for the removal of enlarged inguinal glands; was 4-5 weeks in hospital, during which time his pulse rate was 70-72 when the temperature was normal, and followed the rise of temperature with a rate of 120-130 when the temperature rose to 103°.

In regard to the diagnosis this case has seemed to us to be definitely one of Yellow Fever.

The course of the temperature during the first five days cannot be recorded. A careful inquiry failed to bring to light any improvement of symptoms or drop of temperature during the period before he came to hospital. The absence of this, and the free secretion of urine (40-60 ozs.) daily are not in accord with the published description of serious cases, but when isolated cases occur one does not insist on all the typical text-book symptoms before venturing a diagnosis. The black vomit described by the patient and the black stool observed in hospital on 18th March, 1914, are attributable to epistaxis. On the other hand the combination of other symptoms leaves no room for doubt.

The aspect was not the dullness of Malaria but rather the apprehensiveness common in Yellow Fever.

The persistent slow pulse, though not a typical 'Faget's sign,' appears not to have been present at the commencement of the fever, as a pulse of 90 with a temperature of 99·4 is recorded on the evening of 10th March, 1914. It can hardly be attributable to the jaundice. The late occurrence of the jaundice, which was not apparent before the seventh day, and was not confined to the sclerotics, and in spite of this the appearance of stained granular casts in the urine before sclerotic icterus was visible, supports the diagnosis made. Epistaxis, gastric irritability, and abundance of albumen in the urine passing completely away in convalescence, an early note of tenderness of the spleen and in the epigastric region, are also in its favour.

The absence of malaria parasites in the blood, and much more the abundance and persistence for several days of the albumen in the urine, are against bilious remittent fever.

No red blood cells were found in the urine, and no symptoms of oedema developed.

I consider that the combination in this case of a *slow pulse rate, persisting into convalescence*, together with a *late jaundice* and the *early occurrence of stained casts in the urine*, justifies the diagnosis of Yellow Fever.

Daily blood examination from 14th March, 1914, failed to discover the *Paraplasma flavigenum*, and animal injection of the patient's blood on 17th March, 1914, into a guinea-pig failed to produce any pathological results.

Note by Commission

Some blood films sent home from this case were examined by Dr. C. M. Wenyon, Director of Research in the Tropics to the Wellcome Bureau of Scientific Research, who found some bodies which resembled *Paraplasma*, but which he considered were really artefacts.

Appendix E

Notes on Case No. 102

(See page 556)

This was a prisoner in Freetown gaol, a 'Creole,' aged 24. On the evening of 9th October, 1913, he felt feverish and constipated, and was seen by the native dispenser next morning. He was treated by purgatives, but was not reported to the Medical Officer of the gaol until the morning of 13th October, 1913, when his temperature at 9 a.m. was 99°.

No jaundice ; headache, and pain in back and left shoulder at first complained of, now improved ; no epigastric pain ; vomited bilious matter after taking Epsom salts on 10th October, 1913, but not since. Urine examined daily from 13th to 16th—no albumen, no bile. Temperature, no chart taken but recorded daily at 9 a.m. :—

13th October, 1913	...	99°
14th October, 1913	...	98·4°
15th October, 1913	...	98·8°
16th October, 1913	...	Normal all day.
17th October, 1913	...	Normal ; returned to work ; no headache, etc.

Pulse, never abnormal. Treatment was by laxatives, but no quinine. The blood examined on the 13th October, 1913, showed minute intracorpuscular bodies of doubtful nature. As the suspicion was raised that these bore a resemblance to the illustrations of *Paraplasma flavigenum*, a slide was sent to Dr. Seidelin at Lagos, who kindly examined and returned it with the following note :—

'The presence of a certain amount of precipitate renders the examination somewhat difficult, but I have no doubt that it contains *P. flavigenum*.'

A second slide of the same date showed, on a more detailed examination later, a subtertian malaria ring and an occasional large mononuclear leucocyte with pigment. In addition an object of doubtful nature with a chromatin dot and protoplasm body was observed.

Slides examined on 14th October, 1913, showed nothing abnormal (but it must be said that the smears taken on that day were rather unsatisfactory). A differential leucocyte count on this date gave the following :—

Polymorphs ...	... ...	31·6%
Lymphocytes	... ...	54·0%
Large Monos.	... ...	9·0%
Eosinophils ...	... ...	5·4% (400 cells counted).

15th October, 1913.—Crescents were found in two slides.

16th October, 1913.—Several crescents were found, and one body of doubtful nature.

17th October, 1913.—One malaria ring was again found and doubtful bodies with chromatin dot and protoplasm. Patient returned to the work party.

It is unfortunate that this patient did not come under observation until the fifth day of his illness, as although his symptoms were trivial throughout it is possible that bodies similar to those observed on 13th October, 1913, might have been found more abundantly in the earlier days.

This patient had been in Lagos in 1911 and believes that he had an attack of yellow fever there.* His brother was supposed to have had yellow fever at

* Note by the Commission.—Several outbreaks of yellow fever occurred on the West Coast of Africa in 1911, but no cases were reported from Lagos.

Kissy (near Freetown) in 1912, and the patient himself called his own present illness 'Yellow Fever.' This term, however, he used merely in the meaning intended by the Creoles of Sierra Leone, who call any indisposition when accompanied by a real or imagined heightening of the colour of the urine, whether associated with an actual jaundice or not, 'Yellow Fever.'

Patient was seen again on 4th December, 1913, on discharge from gaol; a blood smear examined showed nothing abnormal.

The notes forwarded to the Commission in connexion with the two other possible cases of Paraplasmosis are so slight that it is not considered worth while to reproduce them in detail The cases may be summarised as follows:—

Case No. 227

A Creole (i.e., an African belonging to Freetown) male, aged 39, short attack of malaria, ushered in by coryza, fever and headache for five days; very slight tinge of jaundice; scanty subtertian (ring forms) infection found. *Other parasites*—one doubtful body, probably malarial. Leucocyte count 7000 per c.mm. Differential count:—

Polymorphs.	53%
Lymphocytes	28%
Large Monos.	17·8%
Eosinophils	1·2%

Case No. 294

A Creole male, aged 24, only seen once at hospital; coryza, cough, etc.; no jaundice; no malarial parasites. *Other parasites*—'bodies of doubtful nature observed.' Differential leucocyte count:—

Polymorphs.	45·7%
Lymphocytes	36·7%
Large Monos. and Trans.	9·6%
Eosinophils	8·0%

Note by Commission

Some blood films, containing bodies marked in rings, sent home from these cases, were examined by Dr. Wenyon, who considered them to be artefacts, in all instances in which they were neither malaria parasites nor leucocytes.

LIST OF FEVER CASES INVESTIGATED DURING THE MONTHS OF MARCH AND APRIL, 1914

BY

G. E. H. Le Fanu, M.B., C.M. (Aberdeen); D.T.M. (Liverpool);
Medical Officer, West African Medical Staff, at Quittah, Gold Coast.

FEVER CASES—

No.	Date	Tribe	Age	Sex	Temp. at time of taking film	Quinine	Clinical signs	Parasites	Albuminuria
1	3.3.14	Awuna	$4\frac{6}{12}$	M.	Not noted	None	Fever 4 days Epigastric pain Prostration	Subtertian	Marked
2	3.3.14	Awuna	4	M.	Not noted	None	Fever Splenic enlargement	Subtertian	No exam.
3	3.3.14	Awuna	2	F.	Not noted	None	Fever Splenic enlargement	Subtertian	No exam.
4	6.3.14	?	7	M.	Not noted	None	Fever	Tertian	No exam.
5	6 3.14	Awuna	4	M.	Not noted	None	Fever Splenic enlargement	None found	No exam.
6	6.3.14	Awuna	1	F.	Not noted	None	Fever Splenic enlargement	Tertian	No exam.
7	11.3.14	Awuna	5	M.	T. 102·4° F. P. 125	None	Fever Splenic enlargement	None	No exam.
8	11.3.14	Awuna	28	F.	Not noted	None	Splenic enlargement Very anaemic Conjunctival mucosae dead white Hydraemia	None	No exam.
9	13.3.14	Bassari	Adult	F.	Not noted	None	Pain in loins	Quartan	No exam.
10	14.3.14	Monrovian	5	M.	Not noted	None	Fever Otalgia Splenic enlargement	Subtertian	No exam.
11	17.3.14	Awuna	7	F.	102·8° F.	None	Fever Abdominal pain Headache Vomiting Jaundice Prostration Splenic enlargement	Subtertian (very numerous)	No exam.
12	18.3.14	Awuna (Mulatto)	$1\frac{3}{12}$	M.	Not noted	None	Fever Splenic enlargement Anaemia	Subtertian	No exam.
*13	22.3.14	Awuna	12	M.	103° F. Pulse 104	None	Fever Vomiting Parietal headache Prostration	None	Albumen on 3rd day
14	22.3.14	Awuna	5	F.	Not noted	None	Fever Abdominal pain Coma	Subtertian	No exam.
15	24.3.14	Awuna	10	F.	Not noted	None	Splenic enlargement Multiple recurrent arthritis	Subtertian	No exam.

* Fuller details of this case are appended.

QUITTAH

Jaundice	Cause of jaundice	Fever	Cause of fever	Ova in stools	Diagnosis	Remarks
None	—	Present	Malaria	Not examined	Malaria	No splenic enlargement. 11.3.14, albumen a mere trace. Recovery
None	—	Present	Malaria	Not examined	Malaria	Spleen 2 in. below costal margin. Recovery
None	—	Present	Malaria	Not examined	Malaria	Spleen 2 in. below ribs. Recovery
None	—	Present	Malaria	Not examined	Malaria	No splenic enlargement. Recovery
None	—	Present	?	*Ascaris lumbricoides Necator americanus*	Helminthiasis and malaria	Eosinophilia. Recovery
None	—	Present	Malaria	Not examined	Malaria	Recovery
None	—	Present	Malaria	—	Malaria	Recovery
None	—	?	—	12.9 14 *Necator americanus*	Ankylostomiasis	Died in convulsions, 12.3.14 11.3.14, Blood showed all signs of advanced anaemia
None	—	?	—	—	Malaria	No splenic enlargement. Recovery
None	—	Present	Malaria	—	Malaria	Recovery
Present	Malaria	Present	Malaria	Not examined	Malaria	Rapid recovery under quinine
None	—	Present	Malaria	Not examined	Malaria	Recovery
None	—	Present	—	25.3.14 *Ascaris lumbricoides*	?	See notes for particulars. Recovery
None	—	Present	Malaria	—	Malaria	Cerebral attack. Rapid Recovery
None	—	None	—	—	Malaria	Recovery

No.	Date	Tribe	Age	Sex	Temp. at time of taking film	Quinine	Clinical signs	Parasites	Albuminuria
16	26.3.14	Awuna	Adult	F.	Not noted	None	Fever Headache Muscular pains Splenic enlargement	Subtertian	No exam.
17	25.3.14	Awuna	Adult	M.	98° F. Pulse over 100	None	Frontal headache Pain in back Cough ? Splenic enlargement	Tertian	Albuminous ? Gonorrhoea
*18	28.3.14	Awuna	30	F.	Normal	None	Headache and epigastric pain for 3 days Pulse 43-44	Subtertian	No albumen
19	28.3.14	Awuna	35	F.	Normal	None	Headache Recurrent fever Muscular pains Splenic enlargement	Present ? Species	Not examined
20	30.3.14	Awuna	6	M.	Not taken	None	Fever Skin dry and hot	Tertian and Quartan	Not examined
21	1.4.14	Awuna	6	M.	Not noted	None	Cough Diarrhoea Fever Splenic enlargement Asthenia	Subtertian	Not examined
22	1.4.14	Awuna	4	M.	99° F.	None	Fever Splenic enlargement	*Plasmodium malariae* and *P. tenue*	Not examined
23	2.4.14	Awuna	1	F.	Not noted	None	Fever Acquired squint Splenic enlargement	Subtertian	Not examined
24	3.4.14	Awuna	21	M.	T. 99·6° F. P. 88	None	Fever	Subtertian	No albumen
25	3.4.14	Awuna	5	F.	T. 99° F. P. 128	None	Fever ? Splenic enlargement	Subtertian	Not examined
*26	3.4.14	Awuna	28	F.	T. 97·6° F. P. 80	None	Headache Epigastric pain Vomiting Jaundice Prostration Faget's sign Albuminuria	None	Severe
27	4.4.14	Awuna	4	F.	Not noted	None	Fever Splenic enlargement Cough	Tertian and Quartan	Not examined
28	6.4.14	Awuna	7	M.	102·2° F.	None	Fever Cough Splenic enlargement	Tertian and Subtertian	No albumen
29	8.4.14	Awuna	Adult	M.	T. 99° F. P. 84	None	Fever Cough	Subtertian	No albumen
30	8.4.14	Awuna	5	M.	97° F.	None	Skin dry and cold Collapsed	Tertian	No albumen
31	9.4.14	Awuna	$4\frac{6}{12}$	F.	Not noted	None	Fever Splenic enlargement	Subtertian	No albumen

* Fuller details of this case are appended.

QUITTAH—*continued*

Jaundice	Cause of jaundice	Fever	Cause of fever	Ova in stools	Diagnosis	Remarks
None	—	Present	Malaria	—	Malaria	Recovery
None	—	—	—	—	Malaria	Spontaneous recovery
None	—	None	—	*Ascaris lumbricoides*	Ascariasis	Recovery after sanatorium treatment. 23.4.14, Pulse 80. 24.4.14, Pulse 70. See notes
None	—	Present	Malaria	Not examined	Malaria	Recovery under quinine
None	—	Present	Malaria	Not examined	Malaria	No splenic enlargement. Recovery under quinine
None	—	Present	Malaria	*Entamoeba histolytica*	Malaria complicated with amoebic dysentery and pulmonary congestion	Quinine and emetine treatment. Died 11.4.14
None	—	Present	Malaria	Not examined	Malaria	Recovery under quinine
None	—	Present	Malaria	Not examined	Malaria	Recovery (squint persists)
None	—	Present	Malaria	Not examined	Malaria	No splenic enlargement. Eosinophils 20 %
None	—	Present	Malaria	*Ascaris lumbricoides*	Malaria and Ascariasis	Recovery under quinine
Very marked	Yellow fever	—	Yellow fever	Not examined	Yellow fever	Died 6.4.14. See notes
None	—	Present	Malaria	Not examined	Malaria	Recovery under quinine
None	—	Present	Malaria	*Ascaris lumbricoides*	Malaria and Ascariasis	Recovery under quinine
None	—	Present	Malaria	Not examined	Malaria	Recovery under quinine
None	—	None	—	Not examined	Pernicious algid malaria	Died 10.4.14
None	—	Present	Malaria	Not examined	Malaria	Recovery under quinine

No.	Date	Tribe	Age	Sex	Temp. at time of taking film	Quinine	Clinical signs	Parasites	Albuminuria
32	11.4.14	Awuna	5	M.	T. 101·2° F. P. 140	None	Fever (4 days) Splenic enlargement	Tertian and Subtertian	No albumen
33	17.4.14	Awuna	7	F.	T. 102·8° F. P. 142 Resp. 60	None	Fever Cough Pain in chest (Lungs clear)	Tertian	No albumen
34	18.4.14	Awuna	8	M.	T. 100° F. P. 150	None	Fever (3 days) Cough with insomnia Conjunctival injection Tongue coated, clean at tip and edges Vomit (food) Congestion left lung Splenic enlargement	None found Pigmented mono-nuclears	No albumen
35	20.4.14	Awuna	$2\frac{2}{12}$	M.	T. 103° F. P. 164	None	Fever (3 days) Cough Constipation	Tertian	No albumen (a trace of compound protein)
36	21.4.14	Awuna	1	M.	T. 103° F. P. 168	None	Fever Vomiting Bloody diarrhoea Splenic enlargement	Tertian	Albumen = slight opalescence
*37	21.4.14	Awuna	6	M.	T. 104·4° F. P. 132	None	Fever Headache Coated tongue Rigors Splenic enlargement	Tertian	Albumen present
*38	23.4.14	Awuna	5	M.	T. 103° F. P. 148	None	Fever Splenic enlargement Epigastric pain	Tertian	Albumen = opacity
39	24.4.14	Awuna	7	F.	T. 99·9° F. P. 150	None	Fever Splenic enlargement	None found	No albumen
40	24.4.14	Awuna	16	F.	T. 100·2° F. P. 98	None	Fever	None found	Urine not obtainable
41	25.4.14	Awuna	$\frac{8}{12}$	F.	T. 104° F. P. 160	None	Fever (4 days) with remission after 2 days ? Splenic enlargement	Subtertian (27.4.14 in thick film; T. 101° F.)	Albumen (3rd day, 27.4.14 = faint opacity
*42	25.4.14	Awuna	10	F.	T. 102·6° F. P. 110	None	Fever Frontal headache Epigastric pain	Tertian (on second and 3rd day; 26.4.14 T. 99·7° F. 27.4.14 T. 99·4° F.)	Albumen (on 2nd day)
43	28.4.14	Awuna	11	M.	101° F. P. 136	None	Fever Bronchitis Coated tongue Headache Abdominal pain	Subtertian	No albumen

* Fuller details of this case are appended.

QUITTAH—*continued*

Jaundice	Cause of jaundice	Fever	Cause of fever	Ova in stools	Diagnosis	Remarks
None	—	Present	Malaria	Not examined	Malaria	Recovery under quinine
None	—	Present	Malaria	Not examined	Malaria	No splenic enlargement. Recovery under quinine
None	—	Present	Malaria	Not examined	Malaria complicated with pulmonary congestion	Recovering, 30.4.14
None	—	Present	Malaria	Not examined	Malaria	Recovery under quinine
None	—	Present	Malaria	Not examined	Malaria	Recovery
None	—	Present	Malaria	22.4.14 *Ascaris lumbricoides*	Malaria	Recovery under quinine. See notes
None	—	Present	Malaria	28.4.14 *Ascaris lumbricoides*	Malaria	Recovery under quinine. See notes
None	—	Present	?	*Oxyuris vermicularis*	? Malaria, with helminthiasis	Eosinophils, 13·5 %. Recovering
None	—	Present	Helminths	*Schistosomum mansoni* *Oxyuris vermicularis* *Ankyl. duodenale*	Helminthiasis	No splenic enlargement. Eosinophilia
None	—	Present	Malaria	Not examined	Malaria	Recovering
None	—	Present	Malaria	Not examined	Malaria	Recovery under quinine. See notes
None	—	Present	Malaria	None	Malaria with bronchitis	Recovering, 2.5.14

Case No. 13

22nd March, 1914.—Male, 12. Servant from Ada.

Spleen not palpable, but slightly enlarged. Vomited twice yesterday; again in the evening, and after Mist. alba this morning: 'green matter.' Parietal headache, and marked prostration. Temperature, 103°. Pulse, 104. Urine: No albumen.

Blood.—Polychromasia of red cells. No parasites. No pigment.

Patient put on quinine.

23rd March, 1914.—Temperature, 98·4°. Pulse, 60. No vomiting. Says he feels better, but still shows marked prostration. Walks and talks in a dazed fashion, his wits are wandering. Urine: a trace of albumen: acid, flocculent opacity on boiling and acidifying with acid. nitric. dil. Rectal temperature, 98·8° F. Severe injection of conjunctivae.

Blood.—No parasites, no pigment.

The quinine was stopped after 2 doses: in all 5 grains of quinine sulphate in acid mixture. Evening temperature, 99·2°.

24th March, 1914.—Temperature, 98·6°. Pulse exactly 60, weak and compressible. Tongue whitish fur, clean at edges and tip. No vomiting. Urine: faint trace of albumen. Looks decidedly brighter. No headache.

Blood.—No parasites and no pigment.

5.30 p.m. Temperature, 98°. Pulse, 58. Has a dazed furtive look, and is inclined to be very restless.

25th March, 1914.—Feeling and looking much better. Tongue still coated. Injection of conjunctivae not so marked. Spleen normal. Urine: free from albumen.

Temperature, 98°. Pulse, 52-55, slightly irregular.

Stool.—Great numbers of eggs of *Ascaris lumbricoides*. ℞. Santonin, gr. iii.

26th March, 1914.—Temperature, 98·2°. Pulse, 74. The boy is quite bright. The difference from yesterday is most marked. Tongue getting clean. Pulse still slightly irregular, improving in tension. Passed 3 *Ascarides*.

29th March, 1914.—Pulse, 80. Complete recovery.

Note.—Association of slow pulse with *Ascaris* infection. The boy left Ada on 21st March, 1914, and arrived on the 22nd at Quittah. The distance is about thirty miles, and his illness may have been due to excessive fatigue and exposure to the sun.

Note by Commission

Some blood films sent home from this case were examined by Dr. C. M. Wenyon, Director of Research in the Tropics to the Wellcome Bureau of Scientific Research, who found some *Paraplasma*-like bodies of doubtful nature in one of the slides. He expressed the opinion that this film was most instructive in shewing how artefacts may simulate parasites.

Case No. 18

28th March, 1914.—Female, about 30. Convict prisoner. 'Frontal headache, epigastric pain, constipation.' Conjunctival vessels congested, showing very clearly on pale mucosa of lids. Tenderness to pressure over epigastrium.

Pulse, 43-44. Urine pale, alkaline, no albumen.

Blood.—Basophilia of red cells? Subtertian parasites.

30th March, 1914.—*Blood:* No parasites seen. Polychromasia and basophilia of reds, some *corps en demi-lune*. Diagnosis: Anaemia.

1st April, 1914.—Pulse, 50. Temperature normal.

Stool contains enormous numbers of eggs of *Ascaris lumbricoides*, also many eggs of *Tricocephalus trichiurus*.

3rd April, 1914.—Pulse, 49. Temperature, 98. Santonin treatment.

6th April, 1914.—Pulse, 59. Stool: *Trichocephalus* and *Ascaris* eggs, but very scarce.

23rd April, 1914.—Pulse, 80. Patient much improved.

24th April, 1914.—Temperature, 99·4°. Pulse, 70. Haemoglobin (Tallquist's scale) 80 per cent. Eosinophilia.

Note.—Association of slow pulse with *Ascaris* infection.

Case No. 26

3rd April, 1914.—Female, 28, prostitute. Has been in Quittah 3 weeks.

The patient was carried to the hospital to-day, when she was seen for the first time at 11 a.m. The deep yellowness of the sclerae of the eyes and her look of utter prostration was most striking. Patient was lying on her back, apparently quite exhausted.

The illness commenced with 'headache.' The patient here points to the glabella. 'Pain over the stomach and all round the ribs. Vomited frequently, vomit "red." Was taken ill five days ago. Has passed no motion since the illness commenced.'

Palpebral conjunctivae injected. Sclerae of eyes deeply jaundiced. Tongue dry, whitish fur on dorsum, tip and edges clean. Breath foul, suffers from pyorrhoea. Splenic dulness not increased. Pressure on the epigastrium, and percussion of the internal organs gives rise to manifestations of great pain. Patient also complains of pain in the legs.

Temperature 97·6° F. Pulse, 80. Compressible and fairly regular. Urine: passed on admission about 2 ozs. of dark brown tinted urine, with a copious deposit found to contain some epithelial debris; columnar cells singly or in groups of 2 or 3, but consisted mostly of granular casts and masses. Intensely acid and loaded with albumen. No bile.

1.30 p.m. Passed 2½ drachms of urine, similar to the first sample but thicker, it almost solidified on boiling.

2.25 p.m. Pulse almost imperceptible, 80. Respiration sighing, occasional moaning. Patient is very restless and throws herself about.

5.45 p.m. Pulse, 78, almost impalpable. ℞ Tinct. Opii. ♏ viii, Tinct. Digitalis ♏ xx. Ordered very small quantities of brandy with water.

6.45 p.m. Pulse, 78, thready and almost imperceptible. Patient is extremely weak. She complains of great pains, especially in the right side over the liver. The gentlest palpation and percussion seem to cause great distress. Voice is reduced to a hoarse whisper.

7 p.m. Temperature, 98°.

8.45 p.m. Restless. Knees drawn up, abdomen retracted. Throws herself about. No urine since 1.30 p.m. Occasional belching.

Skin has been dry all day. Patient is very thirsty, drinks large quantities of water when she can get it. The distension of the stomach generally causes vomiting.

Reputed to have vomited three times during the day, at 12 a.m., 2 p.m., and 9.34 p.m. Two copious specimens of watery brownish-yellow turbid vomit were examined. Both were alkaline and gave a positive blood reaction with guaiacum and ozonic ether.

4th April, 1914.—

12.30 a.m. Vomited 12 ozs. light yellowish-brown turbid fluid.

3 a.m. Vomited 13 ozs., similar to above.

Morning temperature, 95·2°. Pulse, 80.

Evening temperature, 96°. Pulse 78.

12 a.m. Vomit tinged with blood, 14 ozs ; contained great numbers of spindle-shaped epithelial cells, also some squamous cells. Red blood-cells could not be demonstrated except in the shape of cellular debris, coloured by haemoglobin. Reaction alkaline, vomit is foul smelling. Positive blood reaction with guaiacum and ozonic ether.

3.20 p.m. ½ oz. watery vomit, just after a drink.

4.30 p.m. Bloody vomit. The vomit looks exactly like a tawny port turned turbid. Greyish-yellow deposit : debris of red cells, some squamous and spindle-celled epithelium. Now and then fresh, almost unaltered, red blood cells singly or in groups. Reaction : alkaline.

5.45 p.m. Vomited 11 ozs., similar to above but containing some food. Pulse improved in tension. Subsultus tendinum at wrists. Skin ever since admission has been dry, no sweating.

8.30 p.m. Pulse, 70, fuller. Respiration sighing, frequent moaning.

5th April, 1914.—

6.30 a.m. Temperature, 95°. Pulse, 67. Mouth dry. Twitching of corner of mouth. Breathing shallow and sighing. Patient drowsy.

9.30 a.m. Pulse, 68. Occasional belching. Patient very weak. Bladder empty : no urine since day of admission. Skin and mouth dry. Patient has an alert, furtive look, but is drowsy, and dozes off from time to time. Tenderness over right lobe of liver. Subsultus tendinum at wrists.

12 a.m. Pulse 66. Respirations about 18, sighing. Great thirst.

12.45 p.m. Pulse, 62.

4.30 p.m. Vomited a mouthful of watery fluid.

5 p.m. Temperature (skin) under 95°. Pulse, 64. Skin cold, but patient throws off her clothing and complains of heat. She continues restless and gives an occasional loud, sighing moan.

5.10 p.m. About ʒii of vomit : watery, turbid, brownish in colour : gives blood reaction.

5.20 p.m. Twitching of upper eyelid. Great thirst.

6.10 p.m. Occasional twitching of whole body. Is becoming very drowsy. Occasional loud crying moan. Pulse, 61 ; weak and compressible. Surface of body cold.

9 p.m. Subsultus tendinum. Dazed look. Still asking for water. Very drowsy and dozing a great deal. Often moaning, occasional sharp cry, as if in distress. She has said repeatedly that she is going to die. Skin cold. Pulse, 61. No urine : bladder area clear on percussion. There seems now to be little epigastric tenderness.

10 p.m. Retching.

6th April, 1914.—7 a.m. One convulsion reported during night, at 3.24 a.m., with return to consciousness at 3.29 a.m. Pulse, 60-62, regular ; a full minute

could not be counted owing to an irritable restlessness. Patient is very petulant, her mind seems to be wandering. She resented any interference. Haemorrhage in upper and outer quadrant of right conjunctiva. Twitching of lower lip. Respiration, sighing and moaning. There is a curious furtive, questioning expression in the patient's face. Percussion of bladder, nil. Patient has not asked for water since 12 p.m. Given water just now, she spat it out again.

5 p.m. Patient's condition has changed little during the day.

Without any warning she was just seized by a violent fit. The whole body was agitated by violent clonic spasms, which gradually subsided in a few minutes. The head was retracted and the arms jerking about violently. The fit was followed by loud, gasping breathing. Patient remained unconscious for some time after the fit, but the palpebral and conjunctival reflexes could be elicited. The eyes oscillated slowly from side to side a few times, and a slight vertical nystagmus was observed. Blood was taken immediately after the fit (labelled 5 p.m.).

5.30 p.m. Conscious, but very drowsy.

8.30 p.m. Died in a convulsion.

Differential Leucocyte Counts, etc.

	April 3, 1914, 3.30 p.m.		April 4, 1914, 12 a.m.	
Polynuclears	72		71·6	
Lymphocytes	15·8	18·6	10·4	16·2
Irritation Forms	2·8		5·8	
Mononuclears	6·8	8·2	7·8	11·4
Transitionals	1·4		3·6	
Mast cells	0·6		0·2	
Eosinophils	Nil		Nil	
Neutrophil Myelocytes	0·6		0·6	
	100		100	

	April 5, 1914, 1.45 p.m.		April 6, 1914, 5 p.m.	
Polynuclears	79·8		82·4	
Lymphocytes	5·6	8·4	5·6	6·4
Irritation forms	2·8		0·8	
Mononuclears	8·0	10·2	7·0	10·8
Transitionals	2·2		3·8	
Mast cells	Nil		Nil	
Eosinophils	Nil		0·2	
Neutrophil Myelocytes	1·6		0·2	
	100		100	

The red blood cells showed some polychromasia, and numbered many erythroblasts, some of them polychromatic. Some of the red cells contained a chromatin granule. In none of the specimens were any parasites seen.

Post-mortem Examination

Female, aged 28, native of Kpander in Togo. Figure spare, delicate. Whitish frothy fluid exuding from nose and mouth. No injuries. Marked rigor mortis. Sclerae of eyes a deep yellow colour. Haemorrhage in conjunctiva of right eye. Sordes on lips and teeth. Mucosa of gums and lips pale and yellowish.

The dryness of the body and the intense yellow coloration of the connective tissues are most striking. No free fluid in the serous cavities. The blood is very dark and fluid, small post-mortem clots in the heart.

Heart.—Muscle pale. Large vessels and semi-lunar valves deep yellow.

Lungs.—Congested, no oedema. On pressure, some dark blood exudes from the cut surface.

Stomach.—Contains some greyish-brown, thick turbid fluid, with an alkaline reaction. Congestion of, and numerous small punctiform haemorrhages into, the mucosa at the cardiac and pyloric ends, and along the lesser curvature. The mucosa of the fundus and of the greater curvature shows a dark brownish-green discoloration.

Intestines.—First few inches of duodenum congested and haemorrhagic. Small intestine contained two female *Ascarides.* Large intestine contained some pale brown scybala.

Pancreas.—Healthy in appearance.

Gall Bladder.—Bright green in colour. Contained $1\frac{1}{2}$ ozs. of thick, black, tarry liquid.

Liver.—Showed yellow mottling, contrasting with the purplish outlines of the lobules. Similar on section. Fairly firm in consistence and not greasy. Strong fibrous adhesions between anterior surface of right lobe and diaphragm.

Spleen.—Enlarged. Colour deep purplish red. Consistence very firm. Smear : negative.

Kidneys.—Large and firm. Capsules not adherent. On section marked thickening of cortex. The cortical portion and columns of Bertini are of a dark brownish-yellow colour, on which the pyramids streaked with red stand out clearly. Smear : negative.

Bladder.—Mucosa congested around the internal meatus. Contents : a few drops of thick greyish liquid found to consist of masses of ovoid and cubical epithelium with many nuclei scattered about them ; here and there the indication of a granular cast.

Ovaries.—Cystic.

Uterus.—Muscle pale. Mucosa deeply congested and haemorrhagic.

Brain.—Normal in appearance, smear negative. Pia and arachnoid membranes congested. Cerebro-spinal fluid small in amount.

Cause of Death.—Yellow Fever.

Note by Commission

Some blood films sent home from this case were examined by Dr. C. M. Wenyon, Director of Research in the Tropics to the Wellcome Bureau of Scientific Research, who found large numbers of nucleated red cells present. In many cases basophilic degeneration was present, and some red cells shewed what were undoubtedly nuclear remnants and other structures which looked like *Paraplasma.*

Pathological material from this case was examined by Dr. A. C. Stevenson, of the Wellcome Bureau of Scientific Research, who made the following report:—

Pylorus.—Very engorged with blood—great infiltration of small round cells into mucous membrane. Epithelium of surface and outer parts of glands gone, probably largely due to post-mortem changes, as the deeper parts of the glands are healthy.

Small Intestine.—Areas of congestion—infiltration of small round cells in places—epithelium of villi gone, only cells of deepest parts of glands left.

Liver.—Lobules not very defined. Liver cells around central vein show fatty change, as do also those on the outside of the lobule. In the zone between these is a markedly necrotic area in which cells having a markedly acidophil character appear; this zone is also much engorged with blood, which is not seen in the other zones. There is some small round cell infiltration of portal canals.

Kidney.—The convoluted tubules are dilated and filled with granular matter. There are some casts. The vessels of the kidney are much engorged in places. The tubules seem more separated than usual from one another even in places where the capillaries are empty.

Heart Muscle.—The nuclei seem to lie in a clear space in which are some granules of yellow pigment.

Spleen.—Tremendously engorged with blood. Central portions very badly fixed. Malpighian bodies normal. Acicular crystalline pigment present generally in outer zones, amorphous pigment in cells; both these are soluble in acid alcohol.

Suprarenal.—Many areas of necrosis in cortical zone, resembling in character that seen in the liver. In these areas there are two types of cells, in the one type and the commoner, the nuclei stain fairly well, but the cytoplasm has been replaced by large fat droplets; in the other type the cytoplasm is full of small droplets giving a foamy appearance and is markedly acidophilic; the nucleus when seen is generally stained red.

Remarks.—This case is very possibly yellow fever in an early stage. It would be interesting to know if the necrosis in the suprarenal is common.

Case No. 37

21st April, 1914.—Male, 6 years. 'Headache yesterday. Fever last night.' Temperature, 104·4°. Pulse, 132. No jaundice. Spleen palpable. Slight rigors. Skin hot and dry. Tongue shows uniform whitish-yellow coating. No epigastric tenderness. No conjunctival injection. No vomiting. Asthenia.

Urine.—Strongly acid, high coloured, no deposit. Very albuminous; heavy deposit on standing after boiling, etc., about $\frac{1}{4}$.

Ordered a diaphoretic, but no quinine.

Blood.—Tertian parasites. Slight polychromasia of red cells.

22 *April*, 1914.—Temperature, 99°. Pulse, 112. Tongue white fur, clean at tip and edges (the change is probably due to the acid diaphoretic). Slight jaundice: sclerae of eyes have a delicate lemon tint. Has not vomited. 'Fever finished with a heavy sweat.' Has taken his food this morning and looks much better though he is still dull and apathetic.

Urine.—Strongly acid, loaded with albumen. Contains some large mucin casts (? urethral), but no other deposit. Albumen on standing, $\frac{1}{6}$.

Blood.—Tertian schizonts. Numerous *corps en demi-lune.*

NN

5 p.m. Temperature, 98·4. Pulse, 112. Coughing a little.

Urine.—Very acid, albuminous, decreasing in amount.

23rd April, 1914.—Temperature, 98·2°. Pulse, 88. Delicate lemon-coloured jaundice of sclerae. Tongue cleaner. Urine: albumen much less, dense opacity, about $\frac{1}{30}$ on standing. No bile pigment or bile salts (iodine and Hay's test).

℞ Quin. bisulphate grs. 4 per diem.

Blood.—No parasites and no pigment seen.

4 p.m. Temperature, 98·2°. Pulse, 84.

24th April, 1914.—Temperature, 99·4°. Pulse, 92. Tongue almost clean. Eyes still show a very delicate jaundice. Urine: albuminous, transparent opacity.

Blood.—No parasites.

25th April, 1914.—Temperature, 98·2°. Pulse, 94. Every trace of jaundice has disappeared, the sclerae are a clear pearly white.

Urine.—Albumen, faint opacity.

27th April, 1914.—Temperature, 99·6°. Pulse, 78. Urine: no albumen.

Note.—There is a suggestion of sleeping sickness in this case. His brother has pronounced clinical symptoms: adenitis, drowsiness, automatic movements. Blood negative: glands not yet examined.

Case No. 38

23rd April, 1914.—Male, 5 years, an Awuna. Temperature, 103° F. Pulse, 148. 'Fever yesterday, and to-day (came on at 2.30 p.m.).' Spleen palpable Tongue flabby, coated. Epigastric pain. No jaundice. Urine: clear, acid, albumen—opacity.

Blood.—Numerous tertian schizonts. Eosinophilia.

Ordered diaphoretic mixture. No quinine.

24th April, 1914.—Temperature, 98·8° F. Pulse, 104. No jaundice. Urine: very acid, heavy deposit of albumen (boiling, acid. acet. dil., followed by acid. hydrochloric. pur.).

℞ Quin. bisulphate, gr. iv per diem, in mixture.

27th April, 1914.—Temperature, 98·8°. Pulse, 96. Urine: acid, no albumen. Stool: *Ascaris lumbricoides.*

Case No. 42

25th April, 1914.—Female, 10 years, an Awuna. Temperature, 102·6° F. Pulse, 110. Tongue clean. No jaundice. Frontal headache. Epigastric tenderness.

Urine.—No albumen.

Blood.—No parasites found.

26th April, 1914. Temperature, 99·7°. Pulse about 100, irregular with a occasional slowing for a few beats. Urine: deep straw colour, very acid, albumen present, marked opacity.

Blood.—Numerous very small ring and amoeboid forms of malaria parasites, probably tertian.

27th April, 1914.—Temperature, 99·4°. Pulse, 132. No jaundice.

Urine.—Strongly acid, albumen present, faint opacity.

Blood.—Full grown tertian rings, pigmented mononuclears. Eosinophils, 12 per cent.

28th April, 1914.—*Urine:* No albumen.

Recovery.

NATURAL INFECTIONS IN GUINEA-PIGS

BY

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This report deals principally with natural *Paraplasma*-like infections in guinea-pigs.

Some explanation of its late presentation is necessary; logically it should have appeared before the reports which dealt with the experimental transmission of yellow fever in guinea-pigs. The reasons for the delay are twofold. Immediate advantage had to be taken of the occurrence of a case of yellow fever in Lagos, and official notification of the disease is not common. The sequence of events has proved the wisdom of the course followed by the Investigators.

It is necessarily a protracted task to examine and observe a large number of apparently normal guinea-pigs in a search for conditions which simulate an artificially produced attack of yellow fever. Control experiments, it must be remembered, have been conducted systematically since the beginning of the investigations, and the results, for the most part, are incorporated in the present report.

It has appeared desirable to ascertain:—

(*a*) Is there a red-cell inclusion in guinea-pigs, in their natural state, which resembles the parasite described by Seidelin as *Paraplasma flavigenum*?

(*b*) Do guinea-pigs develop an acute febrile illness after the injection of apparently normal blood either from Europeans or negroes?

(*c*) Are there diseases in guinea-pigs which cause the same macroscopical and microscopical lesions as have been found in animals dying after an injection of yellow fever blood?

The results now to be recorded have been obtained from the observation of 153 guinea-pigs. Four of these were supplied to the laboratory from Lagos, and the remainder came from Abeokuta, about 60 miles inland. The blood of 128 was examined during life. Twenty-five of the animals died before a blood examination had been made.

As far as can be ascertained, the guinea-pig is not a native of West Africa. Webster's International Dictionary, 1907, states that the name is probably a mistake for Guiana-pig. Mr. Thompson, Conservator of Forests, Nigeria, who has a wide knowledge of Natural History, believes that, to all intents and purposes, the guinea-pig is indigenous to West Africa, inasmuch as it was brought over by the Portuguese, over 400 years ago. It would appear that the animal is purely a domestic one, in the strict sense of the word. Mr. Thompson has never seen a wild one. It is only in certain towns that the guinea-pig is found in large numbers. The distribution is wide but is not general. Information from various native sources is that the animal is used for food by some people, and is by others used to keep away rats from the compounds.

The laboratory experience shows that when guinea-pigs are confined in large numbers within a small space, deaths are numerous within the first two or three weeks. These deaths take place mostly amongst the young and the weaklings, but occasionally the fully-developed males come to death grips. We have not succeeded in breeding the animals in the laboratory. Occasionally a pregnant female has come in a batch, but the young never survived more than a few days.

Is there a red-cell inclusion in guinea-pigs, in their natural state, resembling *Paraplasma flavigenum*? The peripheral blood of 128 animals has been examined on one occasion at least, and several have been examined more frequently. As a result forty-one guinea-pigs were provisionally put on the suspected list. A second examination of these was made, and it was definitely concluded that intracorpuscular parasites, similar to *Paraplasma flavigenum*, were present in thirty-four. The other suspected bodies were ruled out as artefacts. Thus the proportion of naturally infected guinea-pigs was found to be 26·5 per cent., nearly. Not all of these endo-

globular parasites were similar. They varied in size and shape and in the amount and division of chromatin, but they all had this in common, that they resembled some of the forms of *Paraplasma flavigenum*.

Bearing in mind one of the objections which has been raised against the entity of *Paraplasma flavigenum*, that the elements so classified are nuclear remains, care was taken to weigh the possibility of their being of this nature. 'Nuclear remains' presumably occur most noticeably in toxaemic conditions. Other signs of anaemia were therefore looked for, such as anisocytosis, polychromasia, stippling, and the occurrence of nucleated red cells. It may be stated that polychromasia and stippling were occasionally met with. It was also borne in mind that the presence of the parasite is equally as likely to be the cause of the anaemia, as for the 'parasite' to be the artificial product of a toxic process. Consequently it was decided to inoculate the parasite into other guinea-pigs whose blood was above suspicion. Fourteen inoculations were made, some of them being sub-inoculations.

Experiment 1.—G.-p. 406 was inoculated from G.-p. 397 on 17th March, 1914. G.-p. 397 was first examined on 2nd March, 1914. A minute intracorpuscular body was observed in the blood smear. The animal was killed on the 17th March. The temperature had been normal for the fortnight during which it was under observation. The stomach showed hyperaemia and some petechiae. There was a distinct disc of albumen in the urine with nitric acid. The kidney, liver and spleen were congested. G.-p. 406, previously proved free from blood parasites, was inoculated subcutaneously with a few drops of heart-blood. There was no febrile reaction, and in two examinations no parasites were found in the blood. The animal was killed on 25th March. The stomach was normal and there was no albuminuria. G.-p. 427, also free from blood parasites, was sub-inoculated, from the heart-blood of G.-p. 406, on 25th March. The temperature remained normal. Suspicious intracorpuscular bodies were observed in the blood on the 3rd, 4th, 5th, and 6th days after inoculation. The animal was killed on 4th May, 1914. There was no albuminuria, and the stomach was unaffected. The kidneys, microscopically, showed great congestion.

Experiment 2.—G.-p. 410 inoculated from G.-p. 379. G.-p. 379 was examined on 17th February, 1914. Endoglobular parasites were observed. The temperature of the animal was recorded twice daily, 11th to 24th March, 1914. It was killed on 25th March. The stomach appeared to be normal, and there was no albumen in the urine. G.-p. 410, previously examined and found free from parasites, was inoculated from the heart-blood. There was no febrile disturbance, and, in two examinations, no parasites were found in the blood. G.-p. 410 was killed on 1st April. There was no albumen in the urine, and no lesions were found in the stomach. G.-p. 433, a clean animal, was then inoculated from the heart-blood. It was observed for twenty days, during which time the temperature remained

G.-p. 475 was negative on 21st April and also on 6th May, 16th May, and 18th May, but positive on 20th May.

G.-p. 480 was negative on 22nd April and on 6th May.

G.-p. 487 was negative on 23rd April and on 6th May.

G.-p. 479 was negative on 22nd April and on 6th May.

G.-p. 484 was negative on 23rd April, and positive on 6th May, but negative again on 26th June and on 8th and 17th July.

G.-p. 483 was negative on 22nd April and also on 6th May, but positive on 6th June.

G.-p. 457 was negative on 15th April and on 6th May.

G.-p. 486 was negative on 23rd April and on 6th May.

G.-p. 485 was negative on 23rd April, but positive on 6th May.

These results indicate that a prolonged series of examinations of the blood is necessary before a guinea-pig can be adjudged " clean " for inoculating purposes.

An attempt was made to transmit the parasite found naturally in guinea-pigs to animals which had recovered from an injection of yellow fever blood some months previously.

Experiment 8.—G.-p. 351 inoculated from G.-p. 448, 7th July, 1914. G.-p. 351 was inoculated with yellow fever blood on 6th February. On 7th July, 151 days later, it was injected with blood from G.-p. 448, which at the time, harboured the natural *Babesia*-like parasite. A slight febrile disturbance followed, the average temperature being about 1° F. higher, and the oscillations more marked, during the fortnight after than in the fortnight previous to the injection. No parasites, however, were found in the blood. The animal is still alive.

Experiment 9.—G.-p. 365 inoculated from G.-p. 484, 7th July, 1914. G.-p. 365 was injected with yellow fever blood on 9th February. One hundred and forty-eight days afterwards, 7th July, it was inoculated from G.-p. 484, which at that date showed no parasites in the blood, but which had been marked as positive on 6th June. The temperature behaved as in the previous experiment after the injection, and no parasites were found in the blood. The G.-p. is still alive.

Experiment 10.—G.-p. 366 inoculated from G.-p. 449, 7th July, 1914. The interval, in this instance, was 144 days. G.-p. 449 was positive on 4th April, but not on the 30th April, and it was also negative on 26th June. G.-p. 366 was injected on 7th July. The febrile disturbance was practically nil thereafter, and no parasites appeared in the blood. The animal is still alive.

Experiment 11.—G.-p. 367 inoculated from G.-p. 449, 7th July, 1914. G.-p. 367 was inoculated with yellow fever blood from the same source, and on the same day as G.-p. 366, and was again injected at the same time, 144 days later, from G.-p. 449. No parasites appeared in the blood, and no febrile disturbance followed. G.-p. 367 died after 43 days. At the post-mortem examination there were no gastric lesions, and no albuminuria. Microscopically there was congestion of liver, spleen, and kidney, with cloudy swelling and some desquamation of the epithelial cells in the tubules of the last-named organ.

Experiment 12.—G.-p. 395 inoculated from G.-p. 484, 7th July, 1914. One hundred and thirty-two days elapsed between the inoculation of yellow fever blood and the injection of blood from G.-p. 484. The succeeding febrile disturbance was slight. Parasites were only found in the blood on one occasion, on the 9th day after inoculation. The animal still survives.

Experiment 13.—G.-p. 403 inoculated from G.-p. 448, 7th July, 1914. G.-p. 403 was inoculated from G.-p. 448, 122 days after the injection of yellow fever blood. There was no febrile disturbance. Parasites were found in the blood on the day following inoculation, but not afterwards. The animal died 36 days later. There was one small haemorrhage in the gastric mucous membrane near the pylorus. There was no albuminuria. Microscopically all the organs showed marked congestion.

It is difficult to state any definite conclusion from these experiments, but it would seem that previous injection of yellow fever blood does not prevent an infection, after a four or five months' interval, with the natural *Paraplasma*-like parasites of guinea-pigs.

Do guinea-pigs develop an acute febrile illness after the injection of normal human blood? The following experiments were carried out in this connection:—

Experiment 14.—G.-p. 455. This animal showed an intracorpuscular parasite on 7th May, but blood examinations on 1st May, 2nd, 3rd, and 5th June were negative. On 1st June 0·5 c.c. of blood from a young native adult, in apparent good health, was injected. The course of the temperature can be best judged by comparing the chart with that made from the same g.-p. more than a month previously. It will be seen that there was a slight febrile disturbance. The animal is still alive.

Experiment 15.—G.-p. 458. Parasites were found in the blood on 15th April and 7th May, but the examination was negative on 1st May and on 3rd, 5th and 6th June. On 1st June 0·8 c.c. of blood from one of the native labourers of the laboratory was injected subcutaneously. There was no febrile reaction. The animal died in 5 days. Post-mortem, the stomach showed hyperaemia and a few small stellate haemorrhages. There was no albuminuria. Microscopically there were signs of commencing nephritis, and the liver showed congestion and slight fatty change.

Experiment 16.—G.-p. 473. Parasites were found on 20th April and 1st May, but not on 7th May and 5th June. It was injected with 0·5 c.c. of blood from a native labourer on 2nd June, 1914. There was a slight rise of temperature on the 6th and 7th days and parasites were not found in the blood. The animal died in 20 days. The stomach appeared normal at the post-mortem examination, but albuminuria was present. Microscopically the signs of nephritis were found.

Experiment 17.—G.-p. 478. Parasites were found on 21st April and 5th June, but not on 1st, 7th, and 20th May. It was injected on 2nd June, 1914, with 0·8 c.c. of blood from a fourth native source. The temperature reached 102° F. on the 6th day and 102·4° on the 12th, but these were isolated rises. No parasites were afterwards found in the blood. The animal is still alive.

Experiment 18.—G.-p. 481. The blood examination was positive on 22nd April and negative on 1st and 7th May. Human blood from a fifth native source was injected subcutaneously on 5th June, 1914, 1 c.c. in amount. The temperature remained below 102° F. Parasites were not afterwards found in the blood. The animal is still alive.

normal. Parasites were found in the blood on two occasions, namely, on the day after inoculation and on the tenth day. The animal was killed on 20th April, and no macroscopic lesions were observed at the post-mortem examination. Another sub-inoculation was done, from the heart-blood, into clean guinea-pig 456. This animal is still alive. The temperature was recorded for a fortnight after the inoculation, and it remained normal. Parasites were found in the blood on the day after injection, but not afterwards.

Experiment 3.—G.-p. 418 inoculated from G.-p. 381, 25th March, 1914. G.-p. 381 was found to harbour a *Paraplasma*-like parasite, on 17th February, 1914. The temperature was normal for fourteen days of observation previous to 25th March, when the animal was killed. The stomach was found to be normal, but a trace of albumen was detected in the urine. G.-p. 418, a clean animal, was inoculated from the heart-blood on 25th March. The temperature remained normal until 1st April, when the guinea-pig was killed. No parasites were observed in the blood during life. At the post-mortem examination there was no albuminuria, and no lesions were found in the stomach. The parasite in the blood of G.-p. 381 was afterwards ruled out as an artefact.

Experiment 4.—G.-p. 426 inoculated from G.-p. 392, 25th March, 1914. Parasites were found in the blood of G.-p. 392 on 23rd February. The temperature was recorded from 11th to 25th March, and no febrile disturbance was observed. The animal was killed on 25th March. There were no inflammatory signs in the stomach, but the urine contained albumen. G.-p. 426, previously examined and found free from blood parasites, was inoculated from the heart-blood on 25th March. Suspicious-looking bodies were found in the blood on 27th, 28th, and 29th March, on which last date the guinea-pig died. There was no pyrexia. Macroscopically no lesions were found at the post-mortem examination, but microscopically there was engorgement of all the organs, more especially of the liver, where there was also some slight fatty change. Just before the death of this animal, a sub-inoculation was made into G.-p. 428. This guinea-pig had been previously found free from infection. The temperature ran a normal course for a fortnight afterwards, during which time suspicious-looking bodies were found in the blood on the 4th, 5th, 6th, 7th, 8th, 9th, and 11th days. It was killed on 4th May. No albumen was found in the urine. The stomach was unaffected. Microscopically the kidneys were markedly engorged. On going over the blood smear from G.-p. 392 again, the parasite was ruled out as an artefact.

Experiment 5.—G.-p. 443 injected from G.-p. 434, 6th April, 1914. G.-p. 434 was examined on 26th March. There was a large percentage of stippled corpuscles, and one red-cell inclusion was noted which resembled a parasite. A second examination resulted in its being definitely concluded to be an artefact. The temperature was normal for eight days before 6th April, on which day the animal was killed. No lesions were found in the stomach, but the urine contained albumen. G.-p. 443, free from blood parasites, was inoculated from G.-p. 434 on 6th April. The temperature remained normal for fifteen days, and no parasites appeared in the blood. This animal was killed on 20th April. No macroscopical signs of disease were found at the post-mortem. Another clean guinea-pig, No. 459, was inoculated from the heart-blood of G.-p. 443 on 20th April. This animal is still alive. The temperature remained normal during the first fortnight in which it was recorded. On the day after inoculation, parasites were found in the blood; the examination was negative on the 2nd day and on the 3rd, positive on the 4th, negative again on the 5th, 6th, and 7th, positive on the 8th and 9th, and negative on the 10th day.

Experiment 6.—G.-p. 444 inoculated from G.-p. 431, 6th April, 1914. G.-p. 431 was examined first on 26th March, and a rather large intracorpuscular parasite was observed. The temperature was normal for eight days previous to 6th April, on which day the animal was killed. There was a faint trace of albumen in the urine, but the stomach appeared to be normal. G.-p. 444 was injected with a few drops of heart-blood from G.-p. 431 on 6th April. This animal is still alive, and no parasites have as yet been found in the blood. The temperature maintained a normal course for fifteen days after inoculation.

Experiment 7.—Rat 461 inoculated from G.-p. 458, 16th April, 1914. Parasites were found in the blood of G.-p. 458 on 15th April. The temperature was normal and remained so for fourteen days. Rat 461 was inoculated on 16th April. The temperature of the rat was febrile on the 6th, 7th, and 8th days. *Babesiae* were found in the blood on 2nd, 5th, 7th, 8th, 10th, 12th, 14th, 15th, and 17th days after inoculation. The rat is still alive. G.-p. 479 was inoculated from this rat on 8th May. The animal is still alive. The temperature was not recorded, but parasites were found in the blood on the 2nd day after inoculation.

The results of these experiments are conflicting in some ways, but they show that the *Paraplasma*-like bodies found in some guinea-pigs can be transmitted to others, and that little or no febrile disturbance follows the injection of the infected blood. They show, too, that although albuminuria occurs, there are no macroscopic lesions in the gastric mucosa, such as were found in guinea-pigs dying after an injection of yellow fever blood.

With the object of discovering whether or not the *Paraplasma*-like bodies might be present on some days and absent on others, in the naturally infected guinea-pigs, series of animals were examined at intervals.

G.-p. 439 was positive on 29th March, negative 30th April.

G.-p. 446 was positive on 4th April, negative 30th April.

G.-p. 448 was positive on 4th April, positive 30th April, also positive on 26th June, 8th July, and 17th July.

G.-p. 449 was positive on 4th April, negative on 30th April, and negative also on 26th June, 8th July, and 17th July.

G.-p. 452 was positive on 7th April, negative on 30th April.

G.-p. 454 was negative on 7th April, positive on 30th April.

G.-p. 455 was negative on 7th April, negative on 1st May, positive on 7th May, negative on 2nd, 3rd, and 5th June.

G.-p. 458 was positive on 15th April, negative on 1st May, positive on 7th May, and negative on 3rd, 5th, and 6th June.

G.-p. 473 was positive on 20th April and 1st May, but negative on 7th May and 5th June.

G.-p. 478 was positive on 21st April, and negative on 1st and 7th May and also on 20th May, but positive again on 5th June.

G.-p. 481 was positive on 22nd April, negative on 1st May and also on 7th May.

G.-p. 482 was positive ? on 22nd April, but negative on 1st and 7th May.

G.-p. 471 was negative on 20th April and on 6th May, but positive on 15th May. It was negative again on 18th and 20th May.

G.-p. 475 was negative on 21st April and also on 6th May, 16th May, and 18th May, but positive on 20th May.

G.-p. 480 was negative on 22nd April and on 6th May.

G.-p. 487 was negative on 23rd April and on 6th May.

G.-p. 479 was negative on 22nd April and on 6th May.

G.-p. 484 was negative on 23rd April, and positive on 6th May, but negative again on 26th June and on 8th and 17th July.

G.-p. 483 was negative on 22nd April and also on 6th May, but positive on 6th June.

G.-p. 457 was negative on 15th April and on 6th May.

G.-p. 486 was negative on 23rd April and on 6th May.

G.-p. 485 was negative on 23rd April, but positive on 6th May.

These results indicate that a prolonged series of examinations of the blood is necessary before a guinea-pig can be adjudged " clean " for inoculating purposes.

An attempt was made to transmit the parasite found naturally in guinea-pigs to animals which had recovered from an injection of yellow fever blood some months previously.

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Experiment 9.—G.-p. 365 inoculated from G.-p. 484, 7th July, 1914. G.-p. 365 was injected with yellow fever blood on 9th February. One hundred and forty-eight days afterwards, 7th July, it was inoculated from G.-p. 484, which at that date showed no parasites in the blood, but which had been marked as positive on 6th June. The temperature behaved as in the previous experiment after the injection, and no parasites were found in the blood. The G.-p. is still alive.

Experiment 10.—G.-p. 366 inoculated from G.-p. 449, 7th July, 1914. The interval, in this instance, was 144 days. G.-p. 449 was positive on 4th April, but not on the 30th April, and it was also negative on 26th June. G.-p. 366 was injected on 7th July. The febrile disturbance was practically nil thereafter, and no parasites appeared in the blood. The animal is still alive.

Experiment 11.—G.-p. 367 inoculated from G.-p. 449, 7th July, 1914. G.-p. 367 was inoculated with yellow fever blood from the same source, and on the same day as G.-p. 366, and was again injected at the same time, 144 days later, from G.-p. 449. No parasites appeared in the blood, and no febrile disturbance followed. G.-p. 367 died after 43 days. At the post-mortem examination there were no gastric lesions, and no albuminuria. Microscopically there was congestion of liver, spleen, and kidney, with cloudy swelling and some desquamation of the epithelial cells in the tubules of the last-named organ.

Experiment 12.—G.-p. 395 inoculated from G.-p. 484, 7th July, 1914. One hundred and thirty-two days elapsed between the inoculation of yellow fever blood and the injection of blood from G.-p. 484. The succeeding febrile disturbance was slight. Parasites were only found in the blood on one occasion, on the 9th day after inoculation. The animal still survives.

Experiment 13.—G.-p. 403 inoculated from G.-p. 448, 7th July, 1914. G.-p. 403 was inoculated from G.-p. 448, 122 days after the injection of yellow fever blood. There was no febrile disturbance. Parasites were found in the blood on the day following inoculation, but not afterwards. The animal died 36 days later. There was one small haemorrhage in the gastric mucous membrane near the pylorus. There was no albuminuria. Microscopically all the organs showed marked congestion.

It is difficult to state any definite conclusion from these experiments, but it would seem that previous injection of yellow fever blood does not prevent an infection, after a four or five months' interval, with the natural *Paraplasma*-like parasites of guinea-pigs.

Do guinea-pigs develop an acute febrile illness after the injection of normal human blood? The following experiments were carried out in this connection :—

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Experiment 15.—G.-p. 458. Parasites were found in the blood on 15th April and 7th May, but the examination was negative on 1st May and on 3rd, 5th and 6th June. On 1st June 0·8 c.c. of blood from one of the native labourers of the laboratory was injected subcutaneously. There was no febrile reaction. The animal died in 5 days. Post-mortem, the stomach showed hyperaemia and a few small stellate haemorrhages. There was no albuminuria. Microscopically there were signs of commencing nephritis, and the liver showed congestion and slight fatty change.

Experiment 16.—G.-p. 473. Parasites were found on 20th April and 1st May, but not on 7th May and 5th June. It was injected with 0·5 c.c. of blood from a native labourer on 2nd June, 1914. There was a slight rise of temperature on the 6th and 7th days and parasites were not found in the blood. The animal died in 20 days. The stomach appeared normal at the post-mortem examination, but albuminuria was present. Microscopically the signs of nephritis were found.

Experiment 17.—G.-p. 478. Parasites were found on 21st April and 5th June, but not on 1st, 7th, and 20th May. It was injected on 2nd June, 1914, with 0·8 c.c. of blood from a fourth native source. The temperature reached 102° F. on the 6th day and 102·4° on the 12th, but these were isolated rises. No parasites were afterwards found in the blood. The animal is still alive.

Experiment 18.—G.-p. 481. The blood examination was positive on 22nd April and negative on 1st and 7th May. Human blood from a fifth native source was injected subcutaneously on 5th June, 1914, 1 c.c. in amount. The temperature remained below 102° F. Parasites were not afterwards found in the blood. The animal is still alive.

Experiment 19.—G.-p. 483. No parasites were found in the blood on 22nd April and on 6th May, but on 6th June, the day after injection with 0·1 c.c. blood from a sixth native source, parasites were found. The temperature rose to 102·8° F. on the morning after inoculation, but was normal or subnormal thereafter. Death occurred on the 52nd day. At the post-mortem examination a few fine linear haemorrhages were found in the gastric mucosa, and the urine contained albumen. Microscopic examination of liver, spleen, lung, and kidney showed congestion of all these organs

Experiment 20.—G.-ps. 464 and 466, both clean animals, were subcutaneously inoculated with blood from a European source on 13th May. The amount used was 0·1 c.c. for 464 and 0·4 c.c. for 466. No febrile reaction occurred in either. No. 464 died in fifty-four days, and No. 466 died in 102 days. Post-mortem, the appearances were similar in both,—albuminuria, but no gastric lesion. Signs of nephritis were found microscopically in 464, but not in 466, and the other organs were congested.

Experiment 21.—G.-ps. 468 and 471, both clean animals, were injected as above from a second European source. The amount of blood used for 468 was 0·1 c.c., and for 471 it was 0·4 c.c. Neither showed any pyrexia. G.-p. 468 is still alive. G.-p. 471 showed parasites on the day after inoculation, but not afterwards. Death occurred in eighty-three days. The stomach post-mortem showed a few petechiae, and albumen was present in the urine. Microscopically there was congestion of all the organs.

Experiment 22.—G.-ps. 475 and 476, both clean animals, were injected from a third European source as above, 0·1 c.c. of blood in the former and 0·4 c.c. in the latter. There was no rise of temperature in either subsequent to the inoculation. G.-p. 475 lived thirty-nine days. Parasites were found in the blood on the 6th day. At the post-mortem examination, a faint trace of albumen in the urine was the only macroscopical sign of disease. Microscopical examination showed congestion of all the organs. G.-p. 476 survived forty-six days. There were no gastric lesions and no albuminuria, and the microscopic signs in the organs were similar to those in G.-p. 476.

Experiment 23.—G.-p. 448 inoculated subcutaneously from a fourth European source. This animal showed parasites in the blood on 4th and 30th April, 26th June, and 8th and 17th July. Only a few drops of blood were injected. There was a slight rise of temperature thereafter, 103° F. being reached on the 5th day. Death occurred in 37 days. There were a few injected vessels and one small haemorrhage in the gastric mucous membrane near the pylorus, and the urine contained albumen. Microscopically there was congestion of all internal organs.

Experiment 24.—G.-p. 449 subcutaneously inoculated from a fifth European source. Parasites had been found, previous to the experiment on 4th April, but the blood examination had been negative on 26th June, on the day of inoculation (8th July) and on 17th July. The febrile disturbance was not marked. The animal died in 101 days. The gastric mucosa was injected and hyperaemic, and albuminuria was present.

Experiment 25.—G.-p. 484 inoculated from a sixth European source. Parasites had been found in the blood on 6th May, but the examination was negative on 23rd April and 24th June. It was also negative on the day of inoculation (8th July) and also on 17th July. The temperature chart showed a moderate pyrexia (102° F.—103° F.) for a period of about three weeks thereafter. The animal is still alive.

These results show that some febrile disturbance does follow an injection of apparently normal human blood, in the guinea-pig. The pyrexia, however, was comparatively slight, and the charts differ distinctly from those which recorded the temperature of yellow fever guinea-pigs.

Are there diseases in guinea-pigs which cause the same macroscopical and microscopical lesions as have been found in animals dying after an injection of yellow fever blood? This question can best be answered by giving the results of the work done on the guinea-pigs which have died during the last nine months at the laboratory.

The macroscopical post-mortem appearances have been noted in 94 animals. Of this number, 45 showed albuminuria. The gastric lesions were as follows:—Haemorrhages in 13, hyperaemia in 4, erosions in 3, bloody mucus in 2, petechiae in 2 and a ruptured ulcer in one, making a total of 25 animals affected.

In the above numbers, eight showed both gastric haemorrhages and albuminuria; all the animals in which there were gastric erosions also had albumen in the urine; the two which had bloody mucus in the stomach and the two which presented gastric petechiae also showed albuminuria, and gastric hyperaemia and albuminuria were associated in two cases.

These animals should, however, be put into groups, as some had been inoculated and some also were stock guinea-pigs which died before the blood had been examined.

The largest group consists of twenty-eight guinea-pigs, all of which died within a day or two of their arrival at the laboratory. Four presented gastric haemorrhages, but only one of these had albuminuria. Thirteen animals had albumen in the urine. The organs of five were examined microscopically, but beyond general congestion there was nothing noteworthy. Three of the five had shown albuminuria.

The next largest group numbers twenty-seven. It consists of guinea-pigs whose blood had been examined and where parasites or suspicious intracorpuscular bodies had been found. Guinea-pigs 377, 378, 379, 382, 391, 408, 409, 422, 424, 431, 452, 454, 472, 492, 495, 496 and 508, a total of 17, had all shown parasites. Guinea-pigs 377, 378 and 382 were killed within a day or two of the finding

of the parasites in order to examine the organs. Both 377 and 382 showed no gastric lesions and no albuminuria. Guinea-pig 378 presented only albuminuria. 'Carini-bodies' were found in the lung smears. Guinea-pig 379 was observed for a month before it was killed, during which time the temperature was found to maintain a normal course. Post-mortem, the stomach and urine were normal. Guinea-pigs 391 and 408 were also observed for a month, and a normal temperature was recorded. The animals were killed. Albuminuria was detected post-mortem, but there were no gastric lesions, in 391. The lung smear contained the 'Carini-bodies.' Guinea-pig 408 showed some hyperaemia of the gastric mucous membrane, but no albuminuria. Guinea-pigs 409 and 422 died on the day after parasites had been found in the blood. There were no macroscopical lesions, post-mortem. Guinea-pig 424 was observed for about three months after parasites had first been demonstrated in the blood. The temperature never rose beyond normal limits. Post-mortem, albuminuria was found but there were no inflammatory signs in the stomach. Microscopically, all the organs showed engorgement. Guinea-pig 431 showed parasites in the blood on 26th March. The temperature was recorded and found to be normal until 6th April, when the animal was killed. Albuminuria was the only pathological lesion found at the post-mortem. Guinea-pig 452, another naturally infected animal, was observed for sixty-two days. The temperature was normal for the first fortnight, after which no further record was made. The animal died naturally, and only albuminuria was found post-mortem. The kidney, however, showed the microscopic signs of early nephritis, and the liver showed slight fatty change. Guinea-pig 454 was observed for 130 days, with similar results to the above. No macroscopic lesions were found post-mortem, but there was cloudy swelling and desquamation of epithelial cells in the kidney. Guinea-pigs 472, 492 and 495, in which parasites had been found, all died within three days of observation. All three showed haemorrhagic erosions in the gastric mucosa and also albuminuria. The liver, spleen and kidney in all were intensely engorged, and the liver in the case of No. 495 showed slight fatty change. Guinea-pigs 492 and 495 came in the same batch from Abeokuta, and both died on the same day. Guinea-pig 496

died fifteen days after its arrival from Abeokuta, and it belonged to the same batch as Guinea-pigs 492 and 495. The stomach, post-mortem, appeared to be normal, but albuminuria was present. All the internal organs were congested, there was desquamation in the tubules in the kidney and there was slight fatty degeneration in the liver, microscopically. Guinea-pig 508 died within four days after the blood had been examined and parasites found. The stomach showed haemorrhages, and albuminuria was present. The internal organs were congested, especially the liver and kidney. The remaining ten animals in this group had all shown doubtful intracorpuscular bodies, but they had afterwards been considered as artefacts. Guinea-pig 374 was killed on the day after the first blood examination. The stomach appeared to be normal, the urine contained albumen, and 'Carini-bodies' were found in the lungs. Guinea-pig 381, after running a normal temperature for fourteen days, was killed. Albuminuria was found post-mortem, but there were no other signs of disease. Guinea-pig 383 died a week after it had first been examined. There was some hyperaemia of the gastric mucous membrane, but there were no other gross lesions. Guinea-pig 392 died a month after it was first observed. The temperature never became febrile. Albuminuria was the only pathological sign found. Guinea-pig 394 was killed eleven days after the blood examination. The stomach showed slight haemorrhages. There was no albuminuria. Guinea-pig 397 died after fifteen days' observation. The temperature remained normal during that time. There were petechiae in the gastric mucous membrane, and there was also albuminuria. All the organs were congested, and the microscopic signs of commencing nephritis were present. Guinea-pig 417 died on the day the blood examination was made. At the post-mortem examination it was found that the stomach had ruptured at the site of a large chronic ulcer. Guinea-pig 434 was killed eleven days after the suspicious red-cell inclusions had been found in the blood. The stomach was apparently unaffected, but there was a heavy disc of albumen in the urine with nitric acid. Guinea-pig 460 was under observation for fifteen days before death occurred. Albuminuria was the only gross sign of disease found at the post-mortem. Guinea-pig 488 died two days after the blood had been examined. Both gastric haemorrhages and albuminuria were present at the necropsy.

The third group consists of guinea-pigs in which the blood was free from parasites. Seventeen such animals died before any experimental inoculations had been done, so that presumably the death, in each case, was a natural one. Nine survived only one week or less after their arrival and examination; two others survived only a fortnight, and two lived for nearly four weeks. One animal lived seven weeks, and of the remaining three, one survived 124 days, another 166 days and the last 177 days. Eight of these animals showed no macroscopical signs of disease. Seven others exhibited only albuminuria, whilst one showed gastric haemorrhages and albuminuria, and the last presented some flakes of bloody mucus in the stomach, and also albuminuria. The internal organs of three of these were examined. Guinea-pig 480, in which bloody mucus was found in the stomach, showed the microscopic signs of advanced nephritis. Guinea-pig 494, in which there were no gross lesions, showed only engorgement of the various solid organs. Guinea-pig 500, which showed gastric haemorrhages, presented the signs of nephritis and also some slight fatty change in the liver.

The fourth group consists of guinea-pigs which had been inoculated with blood either from another guinea-pig source or from a human source. Guinea-pigs 366, 367 and 403 had all recovered from an injection of yellow fever blood, and had died subsequent to an injection of blood from naturally infected guinea-pigs. Guinea-pig 366 survived the second inoculation just over three months. There were no gross lesions noted at the post-mortem. The organs were congested, the liver and spleen slightly, the kidney markedly so. Guinea-pig 367 survived the second inoculation for forty-four days. The stomach appeared to be normal. The bladder was empty of urine. The kidney microscopically showed the tubules filled with débris and desquamated cells. Guinea-pig 403 lived for thirty-six days after the second injection. The stomach showed one small haemorrhage near the pylorus. There was no albuminuria. Under the microscope, sections of the organs showed congestion. Guinea-pigs 406, 410, 418, 426 and 443 were inoculated with blood from other guinea-pigs which harboured parasites or doubtful bodies in the red cells. Guinea-pig 406 was killed eight days after inocula-

tion from guinea-pig 397. During these eight days there was no pyrexia. There were no gross signs of disease, post-mortem. Guinea-pig 410 was killed a week after an injection of blood from guinea-pig 379. As in the preceding case, there were no obvious signs of disease at the post-mortem examination, and there was no fever during life. Guinea-pig 418 was subcutaneously inoculated with blood from guinea-pig 381. No pyrexia occurred. Seven days later it was killed. There were no abnormal signs in the stomach and the urine was free from albumen. Guinea-pig 426 was injected with blood from guinea-pig 392. The temperature was not recorded, and at the end of five days the animal died. No gastric lesions were noted. No urine was found in the bladder. The lungs and spleen were congested. The liver showed slight fatty degeneration, and the signs of nephritis were found in the kidney. Guinea-pig 443 was inoculated with blood from guinea-pig 434. A temperature of 101·4° F. was the highest recorded during the fourteen days of observation. The animal was killed at the end of this time. The organs appeared to be normal, and there was no albumen in the urine. Microscopic examination of the solid internal organs showed general acute congestion. All these guinea-pigs were originally clean. Guinea-pigs 427, 428 and 433 were sub-inoculated from the above animals. Guinea-pig 427 was sub-inoculated from 406. The temperature thereafter ran an afebrile course, and on the thirty-sixth day the animal was killed. There were no evidences of inflammatory disturbance in the stomach, and the bladder contained no urine. Microscopic examination of the kidney showed acute congestion. Guinea-pig 428 was sub-inoculated from 426. No fever followed, and the animal was killed on the thirty-sixth day. No signs of disease were found at the post-mortem examination, and the kidney sections showed only engorgement. Guinea-pig 433 was sub-inoculated from guinea-pig 410. The highest point which the temperature reached thereafter was 101° F., and the animal was killed after twenty days. There was no albuminuria, and the stomach appeared normal. The above three guinea-pigs were 'clean' before the sub-inoculation. Guinea-pigs 464, 466, 471, 475 and 476 were all originally 'clean' animals inoculated with blood from an apparently normal human source (European). Guinea-pig 464

died twenty-four days afterwards. No febrile disturbance followed the injection. The post-mortem examination revealed hyperaemia of the gastric mucous membrane, and albumen in the urine. The lung, spleen and liver microscopically were congested, and the kidney showed acute nephritis. Guinea-pig 466 was inoculated from the same source as 464. There was no pyrexia after the injection of blood. The animal survived eighty-four days. Post-mortem, the stomach contained a few small flakes of bloody mucus, and albuminuria was present. The lung, spleen, liver and kidney microscopically showed engorgement. Guinea-pig 471 survived sixty-five days. No fever occurred. At the post-mortem examination petechiae were noted in the stomach and albuminuria was detected. All the internal organs were congested. Guinea-pig 475 lived for twenty-nine days after inoculation. The temperature remained below the level of 101° F. Albuminuria was the only gross sign of disease found, and the organs showed nothing more noteworthy than general congestion. Guinea-pig 476 was inoculated from the same source as 475. No fever occurred and death took place on the forty-sixth day. No abnormalities were observed post-mortem, and there was congestion of all the organs. Guinea-pigs 458, 473 and 483 were all injected with blood from native labourers. All these animals had shown intracorpuscular parasites. Guinea-pig 458 showed no fever, and death occurred in five days. Haemorrhages were found in the stomach, but no albumen was detected in the urine. The lungs and spleen were congested, the liver showed slight fatty degeneration and the signs of nephritis were present. Guinea-pig 473 recorded a temperature of 101·8° F. on the sixth and seventh days after inoculation, but the general level was below 101° F. The animal died in twenty days. One small haemorrhage was found in the stomach, and there was albuminuria. The kidney showed the signs of nephritis. The other organs were congested. Guinea-pig 483 lived for one and a half months after injection. There was no fever. The stomach showed haemorrhages, and there was albumen in the urine. All the organs were congested. Guinea-pigs 448 and 449 were both naturally infected, and both were injected with apparently normal blood from Europeans. Guinea-pig 448 survived thirty-seven days. There was slight fever. The stomach presented one small

haemorrhage, and the urine found in the bladder, post-mortem, contained albumen. All the organs were congested. Guinea-pig 449 lived for over three months. There was no febrile disturbance. The mucous membrane of the stomach was injected and there was albuminuria. The organs were congested.

Thus the results of the microscopical examination of the organs showed nephritis and fatty liver in five, nephritis alone in seven others, and general congestion in the remainder. It will be observed that a considerable proportion of the animals presented either gastric haemorrhages or albuminuria, or both. The gastric conditions, however, were never so intense as in those guinea-pigs which died after an injection of yellow fever blood. Albuminuria was very commonly observed. In this connection, it must be stated that the weather during July, August and September was colder than normal, and that the nights were sometimes distinctly chilly. It may be, therefore, and certainly the impression was felt, that nephritis occurred in some of the guinea-pigs as a result of the unusual atmospheric conditions.

Two series of observations were made on batches of guinea-pigs, confined in a room 18 feet square. The floor was of cement, and windows and doors were mosquito-proof.

Batch 'A' was composed of thirty-five animals. One well-grown guinea-pig was dead two days afterwards. Five days later two young ones had died. Two more succumbed in the next two days, one young and one full grown. Three more adults died within the next few days, making a total of eight deaths in seventeen days.

Batch 'B' comprised thirty-nine guinea-pigs. Two were dead on arrival, and twenty other deaths occurred within the first three weeks. Only five of these were examined post-mortem. Two of these (492 and 495, see page 614) showed both albuminuria and gastric haemorrhages, and the remaining three had albumen in the urine. Nine other guinea-pigs died within the ensuing four weeks. In this group, two exhibited both gastric haemorrhages and albuminuria, six showed only albuminuria, and the last showed no gross lesions. The ten guinea-pigs which survived were examined with especial care thereafter, and *Paraplasma*-like bodies were found in the blood of four.

The conclusion that has been arrived at is that the clinical and pathological picture presented by the guinea-pigs dealt with in the present paper differs in degree more than in kind from that noted in yellow fever guinea-pigs, and it is unfortunate, in a sense, that other experimental animals have not been more largely used in the actual yellow fever work. This was, of course, due to the difficulty in obtaining animals other than guinea-pigs.

It remains to be stated that the stains used for the blood smears were Giemsa's (old formula) and Leishman's. The sections were usually fixed in sublimate alcohol and stained with haemalum and eosin, except when it was desired to examine particularly for fat, when formalin was the fixative and sudan III the stain used.

We wish to record our indebtedness to Dr. A. R. Paterson for much help in the examination of the blood smears, and to Sergt. F. G. Phipps for his assistance with the experimental animals, for fixing and cutting the sections and for his consistent work generally.

Tables and Charts are appended. The last six Charts are from guinea-pigs injected with yellow fever blood. They are given for comparison with the others.

Medical Research Institute,
Yaba, Lagos,
24th October, 1914.

TABLE I.—Giving particulars of macroscopical post-mortem findings.

G.-p. No.	How affected	Stomach	Urine
*374	Natural infection (afterwards ruled out)	o	o
377	Natural infection	o	o
*378	,, ...	o	o
*379	,, ...	o	o
381	Natural infection (afterwards ruled out)	o	Albumen
382	Natural infection	o	o
383	Natural infection (afterwards ruled out)	Hyperaemia	None
388	Normal	o	Albumen
*391	Natural infection	o	Albumen
392	Natural infection (afterwards ruled out)	o	Albumen
394	,, ,, ...	Haemorrhages	o
405	Normal	o	o
406	Clean g.-p. inoculated from 397	o	o
408	Natural infection (afterwards ruled out)	Hyperaemia	None
409	Natural infection	o	o
410	Clean g.-p. inoculated from 379	o	o
413	Stock g.-p., unexamined	One haemorrhage	o
414	,, ,, ...	o	Albumen
415	,, ,, ...	o	o
416	Normal	o	o
417	Natural infection (afterwards ruled out)	Old ulcer ruptured	o
418	Clean g.-p. inoculated from 381	o	o
422	Natural infection	o	o
429	Normal	o	Albumen
430	,, ...	o	Albumen
431	Natural infection	o	Albumen
433	Clean g.-p. sub-inoculated from 410 $\leftarrow$ 379 ...	o	o
434	Natural infection (afterwards ruled out)	o	Albumen
437	Normal	o	o
438	,, ...	o	Albumen
460	Natural infection (afterwards ruled out)	o	Albumen
465	Normal	o	Albumen

* These guinea-pigs showed 'Carini-bodies' in the lung smear.

Table I.—*Continued*

G.-p. No.	How affected	Stomach	Urine
470	Normal	o	o
474	„	o	o
486	„	o	o
488	Natural infection (afterwards ruled out)	Haemorrhages	Albumen
498	Normal	o	Albumen
St. 1	Stock g.-p., unexamined	o	o
St. 2	„ „	One haemorrhage	o
St. 3	„ „	o	Albumen
St. 4	„ „	o	o
St. 5	„ „	One haemorrhage	o
St. 6	„ „	o	o
St. 7	„ „	o	o
St. 8	„ „	o	o
St. 9	„ „	o	o
St. 10	„ „	o	Albumen
St. 11	„ „	o	Albumen
St. 12	„ „	o	Albumen
St. 13	„ „	o	o
St. 14	„ „	o	o
St. 15	„ „	o	o
St. 16	„ „	o	Albumen
St. 17	„ „	o	Albumen
St. 18	„ „	o	Albumen
St. 19	„ „	Haemorrhages	Albumen
St. 20	„ „	o	Albumen
St. 21	„ „	o	Albumen
St. 22	„ „	o	Albumen
St. 23	„ „	o	Albumen
St. 24	„ „	o	o
St. 25	„ „	o	o

Table II.—Giving particulars of the guinea-pigs in which a complete post-mortem examination was made.

G.-p. No.	How affected	Period of observation	Post-mortem lesions: Macroscopical: Stomach	Post-mortem lesions: Macroscopical: Urine	Post-mortem lesions: Microscopical: Kidney	Post-mortem lesions: Microscopical: Liver	Post-mortem lesions: Microscopical: Spleen
366	Convalescent 144 days after y.f. inoculation from 449	97 days	o	o	Congestion	Congestion	Congestion
367	,, ,, ,,	44 days	o	o	Nephritis	Congestion	Congestion
397	Natural infection	43 days	Petechiae	Albumen	Nephritis	Congestion	Congestion
403	Convalescent 122 days after y.f. inoculation from 448	36 days	Haemorrhage	o	Congestion	Congestion	Congestion
419	Normal	166 days	o	o	Congestion	Congestion	Pigment
424	Natural infection	78 days	o	Albumen	Congestion	Congestion	Congestion
426	Inoculated from 392	4 days	o	o	Nephritis	Fatty	Congestion
427	Inoculated from 406 <—397	Killed 40 days	o	o	Congestion	Congestion	Congestion
428	Inoculated from 426 <—392	Killed 36 days	o	o	Congestion	Congestion	Congestion
443	Inoculated from 434	Killed 14 days	o	o	Congestion	Congestion	Congestion
448	Natural infection, injected with European blood ...	37 days	Injection, haemorrhage	Albumen	Congestion	Congestion	Congestion
449	,, ,, ,, ...	101 days	Injection	Albumen	Congestion	Congestion	Congestion
452	Natural infection	62 days	o	o	Nephritis	Fatty	Congestion
454	,, ,, ...	123 days	o	o	Nephritis	Congestion	Pigment
458	Natural infection, injected with negro blood	5 days	Hyperaemia, haemorrhages	o	Nephritis	Fatty	Congestion
462	Normal	85 days	o	o	Congestion	Congestion	Congestion
464	Clean, injected with European blood	54 days	Congestion	Albumen	Nephritis	Congestion	Congestion
466	,, ,, ...	102 days	A flake of bloody mucus	Albumen	Congestion	Congestion	Congestion
471	,, ,, ...	83 days	Minute haemorrhages	Albumen	Congestion	Congestion	Congestion
472	Natural infection	1 day	Haemorrhages	Albumen	Congestion	Congestion	Congestion

TABLE II.—*Continued*

G.-p. No.	How affected	Period of observation	Post-mortem lesions				
			Macroscopical		Microscopical		
			Stomach	Urine	Kidney	Liver	Spleen
473	Natural infection, injected with negro blood	20 days	One fine haemorrhage	Albumen	Nephritis	Congestion	Congestion
475	Clean, injected with European blood	39 days	o	Albumen	Congestion	Congestion	Congestion
476	,, ,, ...	46 days	o	o	Congestion	Congestion	Congestion
480	Normal	123 days	A flake of bloody mucus	Albumen	Nephritis	Congestion	Congestion
483	Clean, injected with negro blood	52 days	Few linear haemorrhages	Albumen	Congestion	Congestion	Congestion
487	Normal	177 days	o	Albumen	Congestion	Congestion	Congestion
492	Natural infection	3 days	o	o	Congestion	Congestion	Congestion
494	Normal	44 days	o	o	Congestion	Congestion	Congestion
495	Natural infection	3 days	o	o	Congestion	Congestion	Congestion
496	,, ...	14 days	o	o	Nephritis	Fatty	Congestion
500	Stock g.-p., unexamined	—	o	o	Nephritis	Fatty	Congestion
508	Natural infection	6 days	Haemorrhages	Albumen	Congestion	Congestion	Congestion
C	Stock g.-p., unexamined	—	o	o	Nephritis	Congestion	Congestion
D	,, ,, ...	—	o	o	Congestion	Congestion	Congestion
E	,, ,, ...	—	o	o	Congestion	Congestion	Congestion
F	,, ,, ...	—	o	o	Congestion	Congestion	Congestion
G	,, ,, ...	—	o	o	Congestion	Congestion	Congestion
H	,, ,, ...	—	o	o	Congestion	Congestion	Congestion

Nephritis and fatty liver 4
Nephritis 11
Pigment in spleen ... ... 2 (The amount of yellowish-brown pigment appeared to be excessive).

Table III.—Clean animals inoculated from naturally-infected guinea-pigs.

Animal No.	Inoculated from g.-p. No.	Fever	Parasites	Length of life	Post-mortem findings
g.-p. 406	397	Nil	None	Killed 9th day	Nil
„ 410	379	Nil	None	Killed 8th day	Nil
„ 418	381	Nil	None	Killed 8th day	Nil
„ 426	392	Not recorded	2nd, 3rd, and 4th days	Died 5th day	Nephritis, fatty liver
„ 443	434	Slight	None	Killed 14th day	Nil
„ 444	431	Slight	None	Still alive	—
Rat 461	458	Slight	2nd, 5th, 10th, 12th, 14th, and 15th days	Still alive	—

Table IV.—Clean guinea-pigs sub-inoculated from naturally-infected guinea-pigs.

G.-p. No.	Inoculated from	Fever	Parasites	Length of life	Post-mortem findings
427	g.-p. 406	Nil	3rd—6th days	Killed 41st day	Nil
428	„ 426	Nil	4th, 9th, and 11th days	Killed 37th day	Nil
433	„ 410	Nil	2nd and 10th day	Killed 20th day	Nil
459	„ 443	Nil	2nd, 4th, 8th, and 9th day	Still alive	—
479	Rat 461	Slight	2nd day	Still alive	—
490	Rat 461	Slight	Not examined	Died on 1st day	—
456	g.-p. 433	Nil	2nd day	Still alive	—

Table V.—Guinea-pigs inoculated with normal European blood.

G.-p. No.	Condition	Fever	Length of life	Post-mortem findings
448	Natural infection	Slight	Died 38th day	Gastric haemorrhages, albuminuria
449	Natural infection	Slight	Died 102nd day	Gastric hyperaemia, albuminuria
464	Clean	Nil	Died 55th day	Gastric hyperaemia, albuminuria, nephritis
466	Clean	Nil	Died 103rd day	Bloody mucus in stomach, albuminuria
468	Clean	Nil	Still alive	—
471	Natural infection	Nil	Died 84th day	Gastric petechiae, albuminuria
475	Natural infection	Nil	Died 40th day	Albuminuria
476	Clean	Nil	Died 47th day	Nil
484	Natural infection	Slight	Still alive	—

Table VI.—Guinea-pigs inoculated with normal negro blood.

G.-p. No.	Condition	Fever	Length of life	Post-mortem findings
455	Natural infection	Well marked	Still alive	—
458	Natural infection	Nil	Died 6th day	Gastric haemorrhages, nephritis, fatty liver
473	Natural infection	Distinct	Died 21st day	Gastric haemorrhages, nephritis, albuminuria
478	Natural infection	Slight	Still alive	—
481	Natural infection	Slight	Still alive	—
483	Natural infection	Nil	Died 53rd day	Gastric haemorrhages, albuminuria

Table VII.—Guinea-pigs convalescent after inoculation with yellow fever blood, inoculated from naturally-infected guinea-pigs.

G.-p. No.	Fever	Parasites	Length of life	Post-mortem findings
351	Very slight	Nil	Still alive	—
365	Very slight	Nil	Still alive	—
366	Very slight	Nil	Died 98th day	Nil
367	Nil	Nil	Died 44th day	Nephritis
395	Nil	9th day	Still alive	—
403	Nil	2nd day	Died 37th day	Gastric haemorrhage

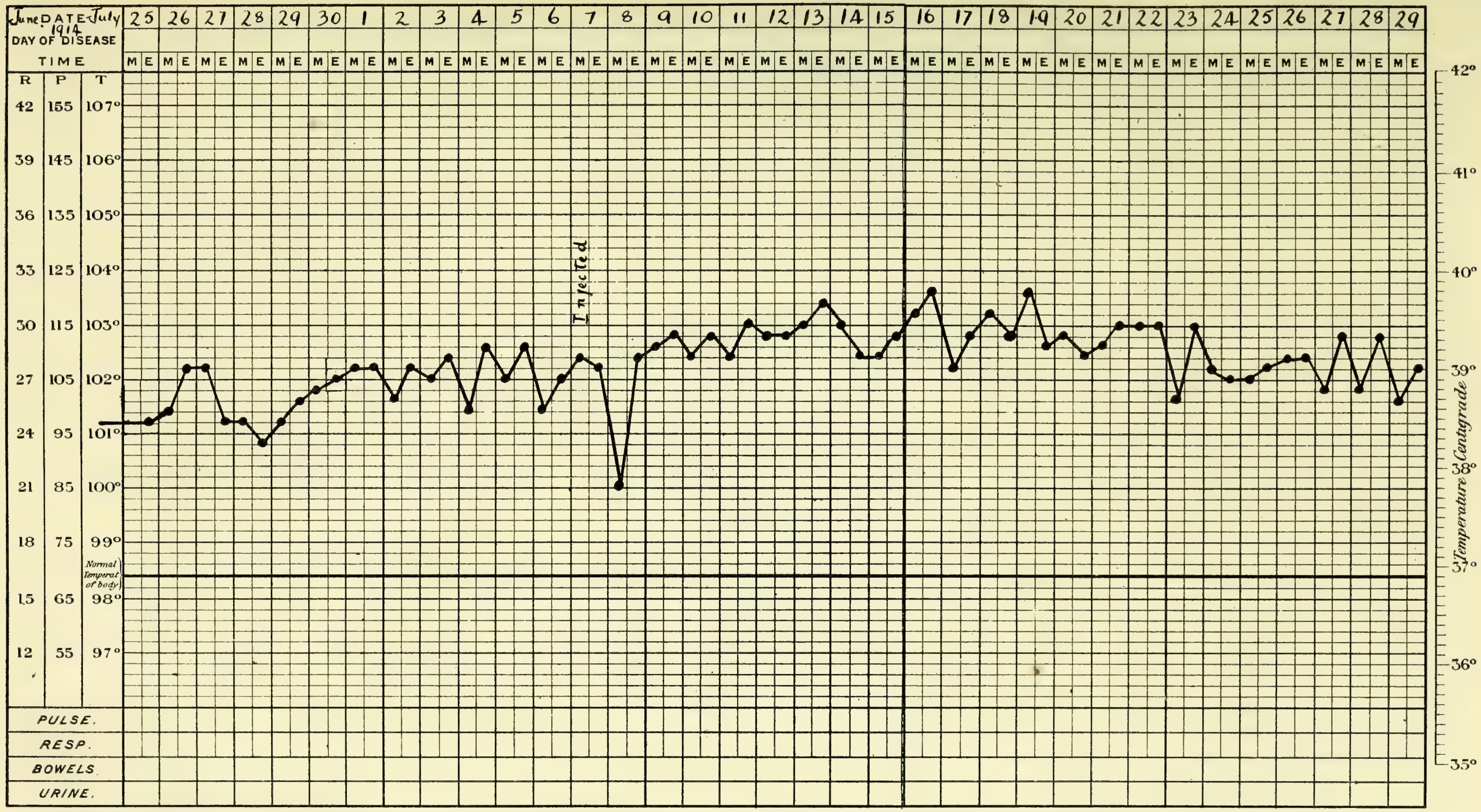

Chart 1. G.-p. 351, convalescent (4 months) after injection of yellow fever blood ; injected from g.-p. 448 (natural infection).

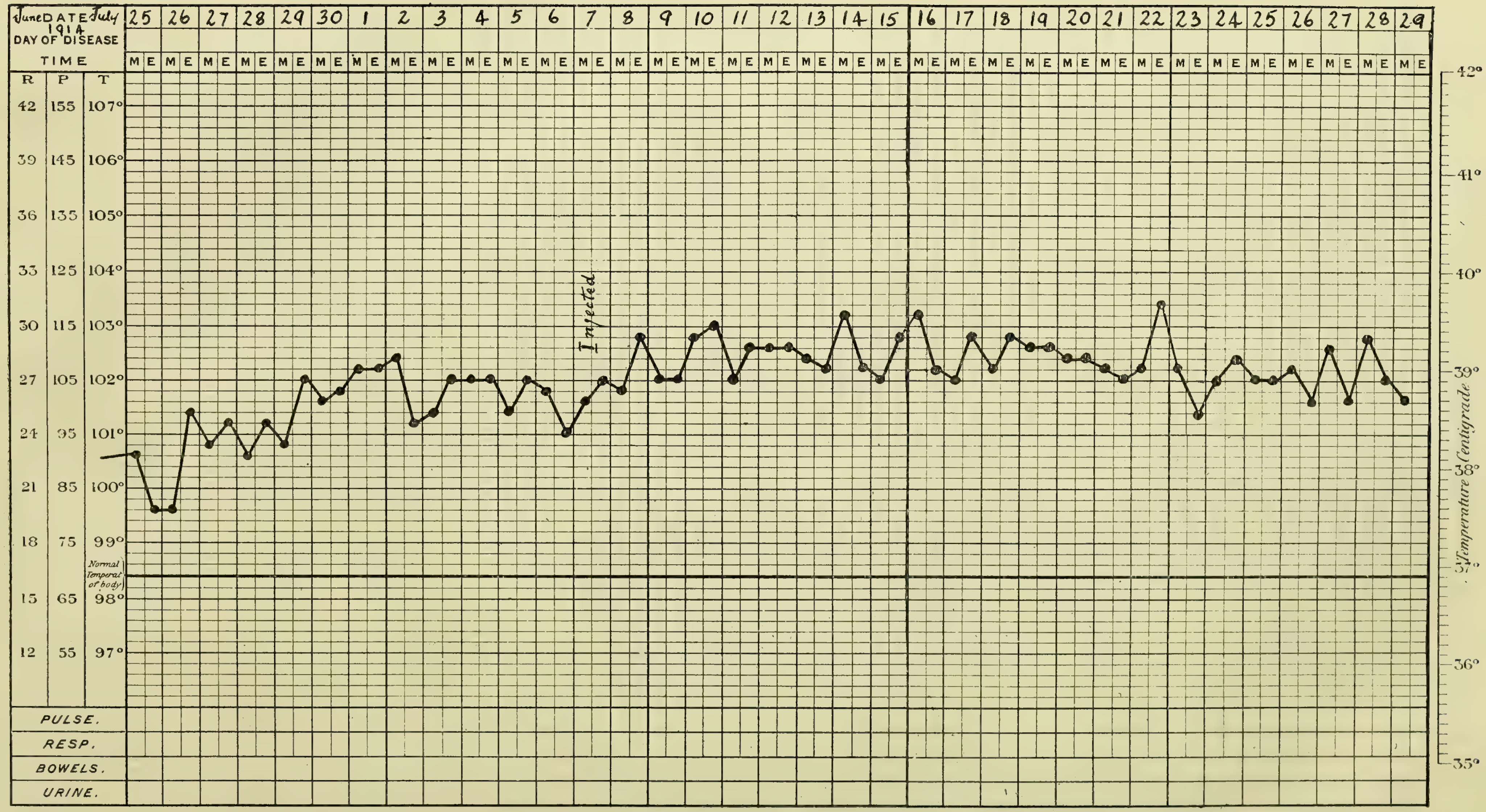

Chart 2. G.-p. 365, convalescent (4 months) after injection of yellow fever blood; injected from g.-p. 484 (natural infection).

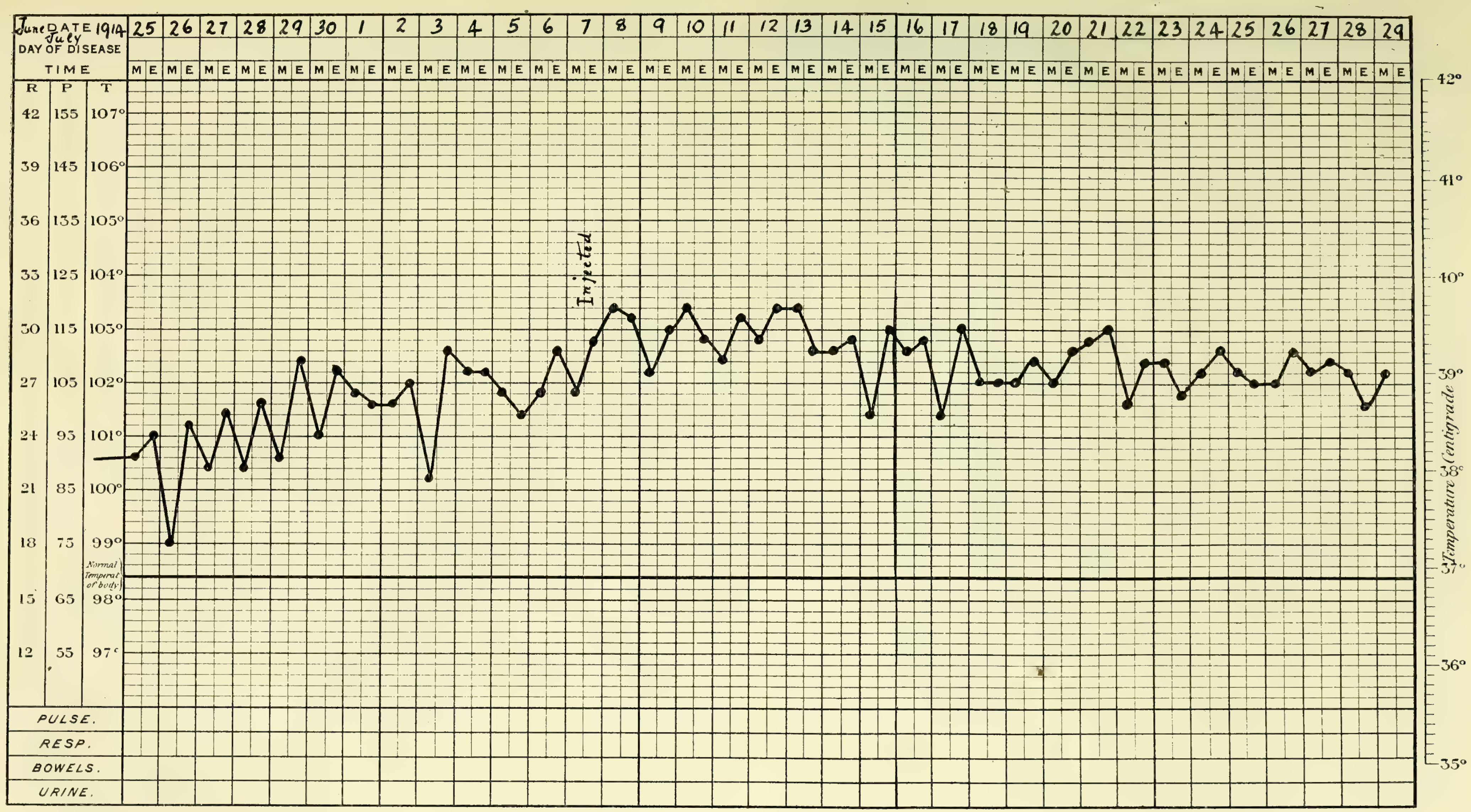

Chart 3. G.-p. 366, convalescent (4 months) after injection of yellow fever blood; injected from g.-p. 449 (natural infection).

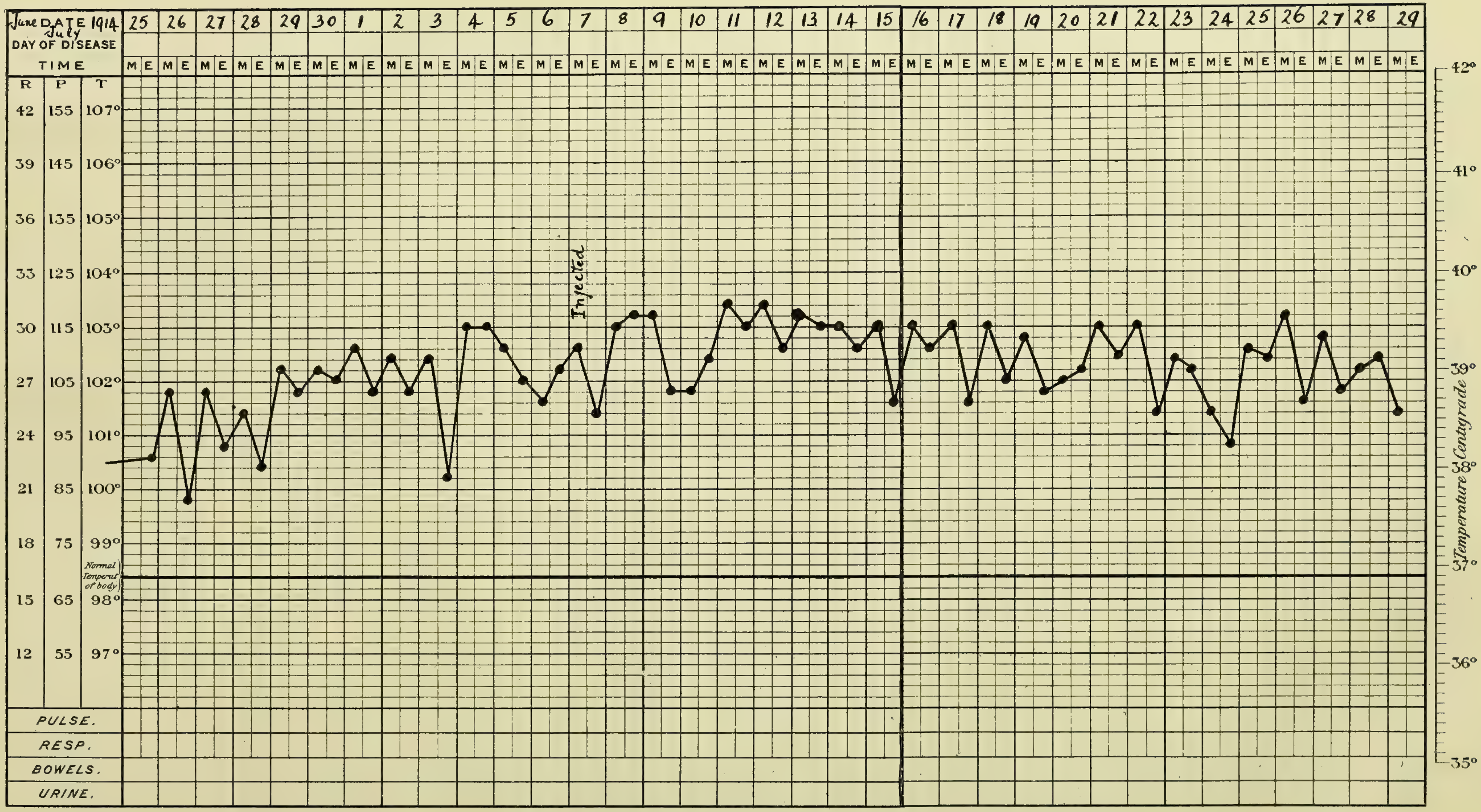

Chart 4. G.-p. 367, convalescent (4 months) after injection of yellow fever blood; injected from g.-p. 449 (natural infection).

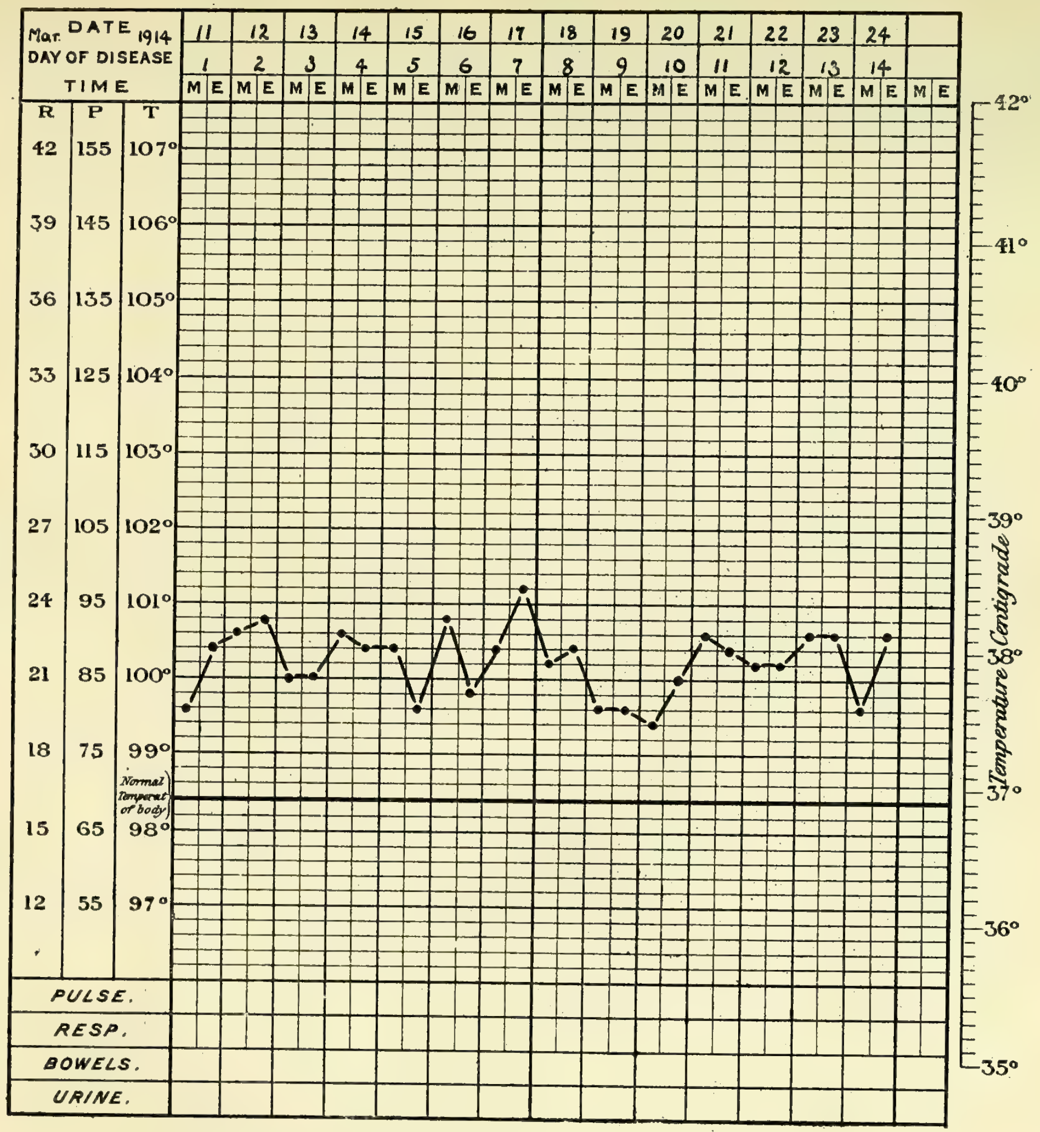

Chart 5. G.-p. 379, natural infection.

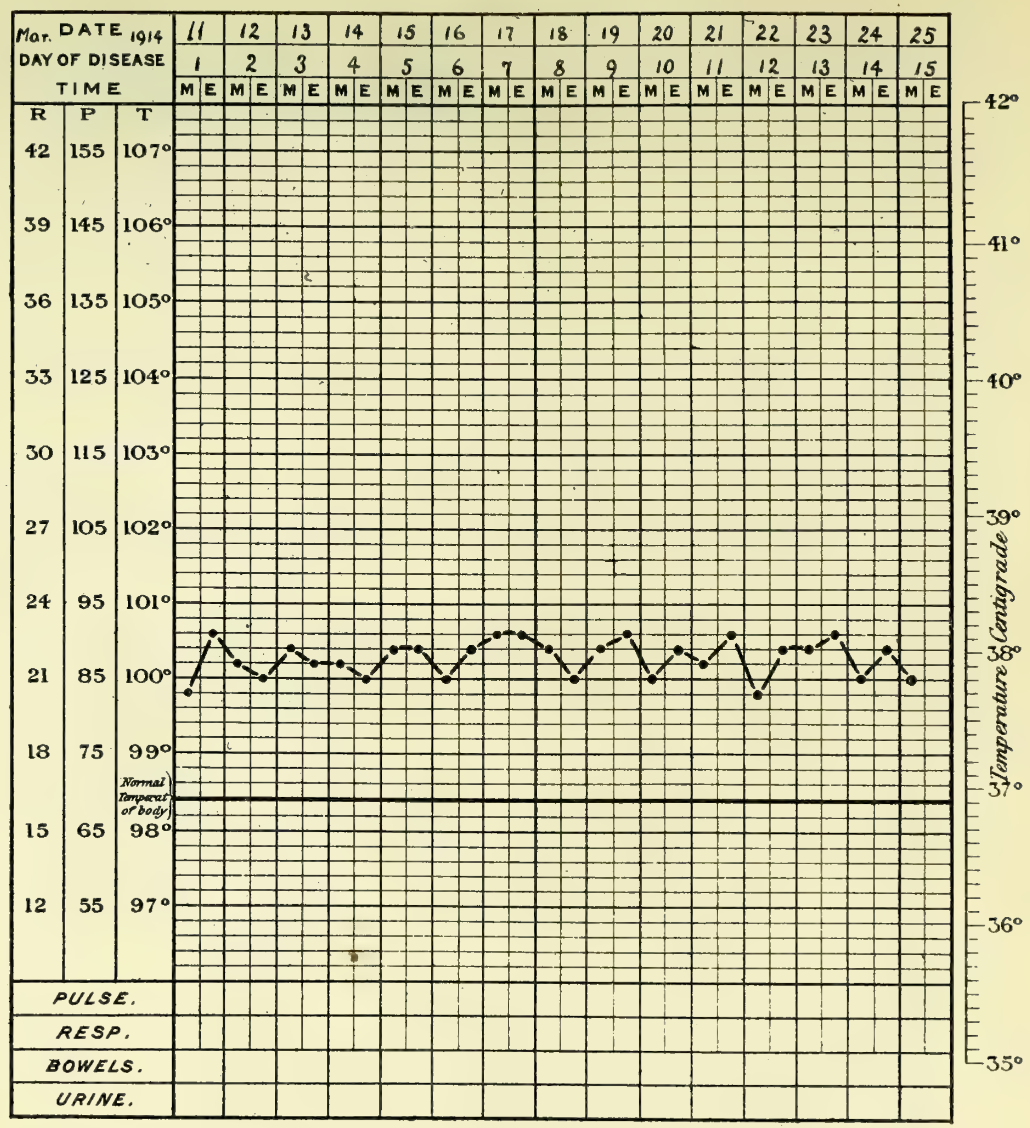

Chart 6. G.-p. 381, ? natural infection (supposed parasite found to be artefact).

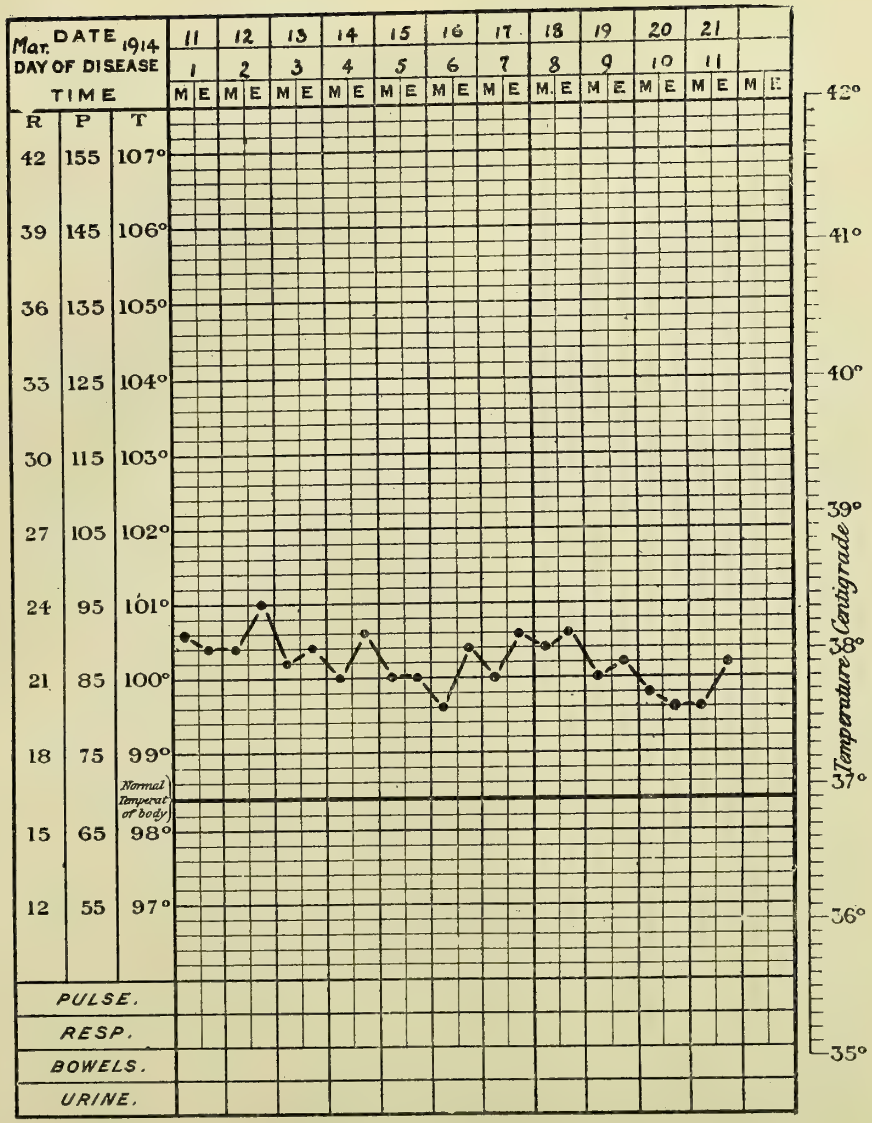

Chart 7. G.-p. 391, natural infection.

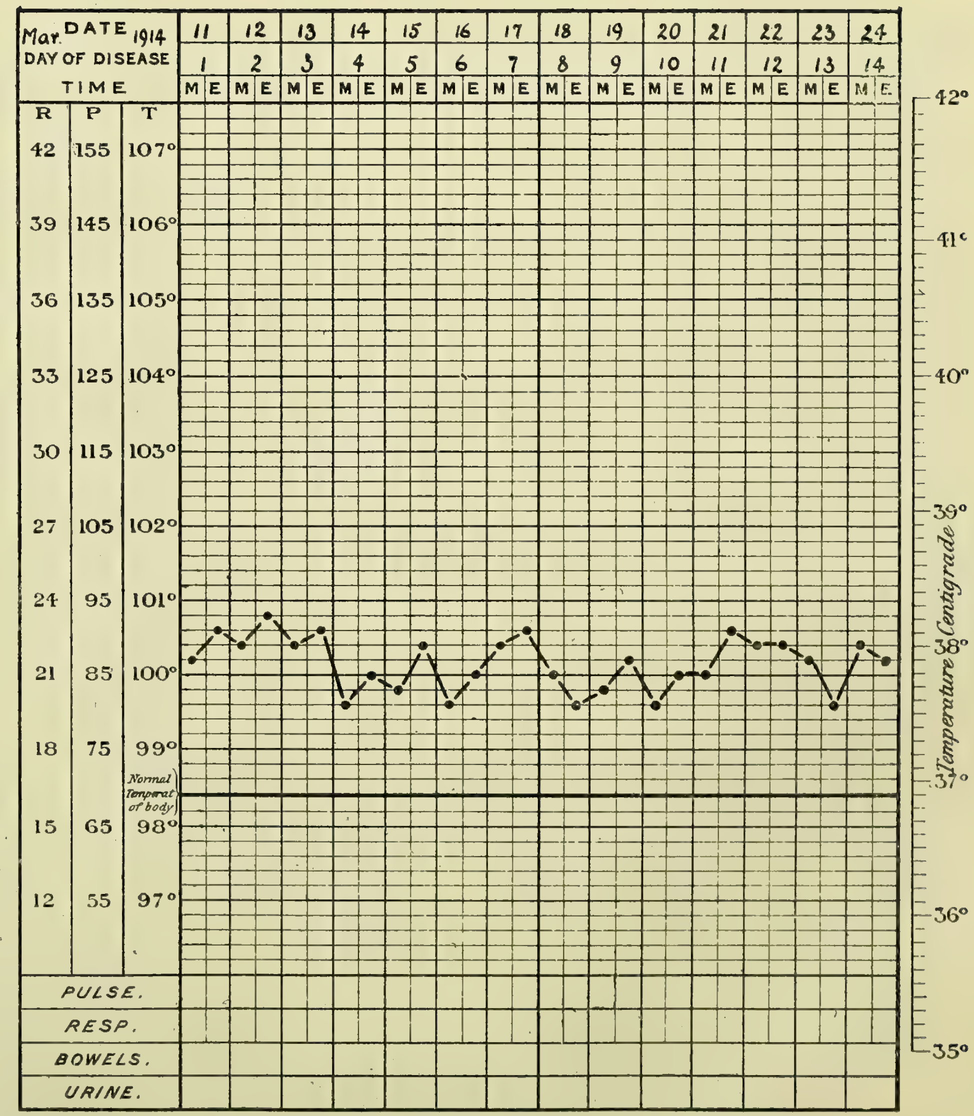

Chart 8. G.-p. 392, ? natural infection (supposed parasite found to be artefact).

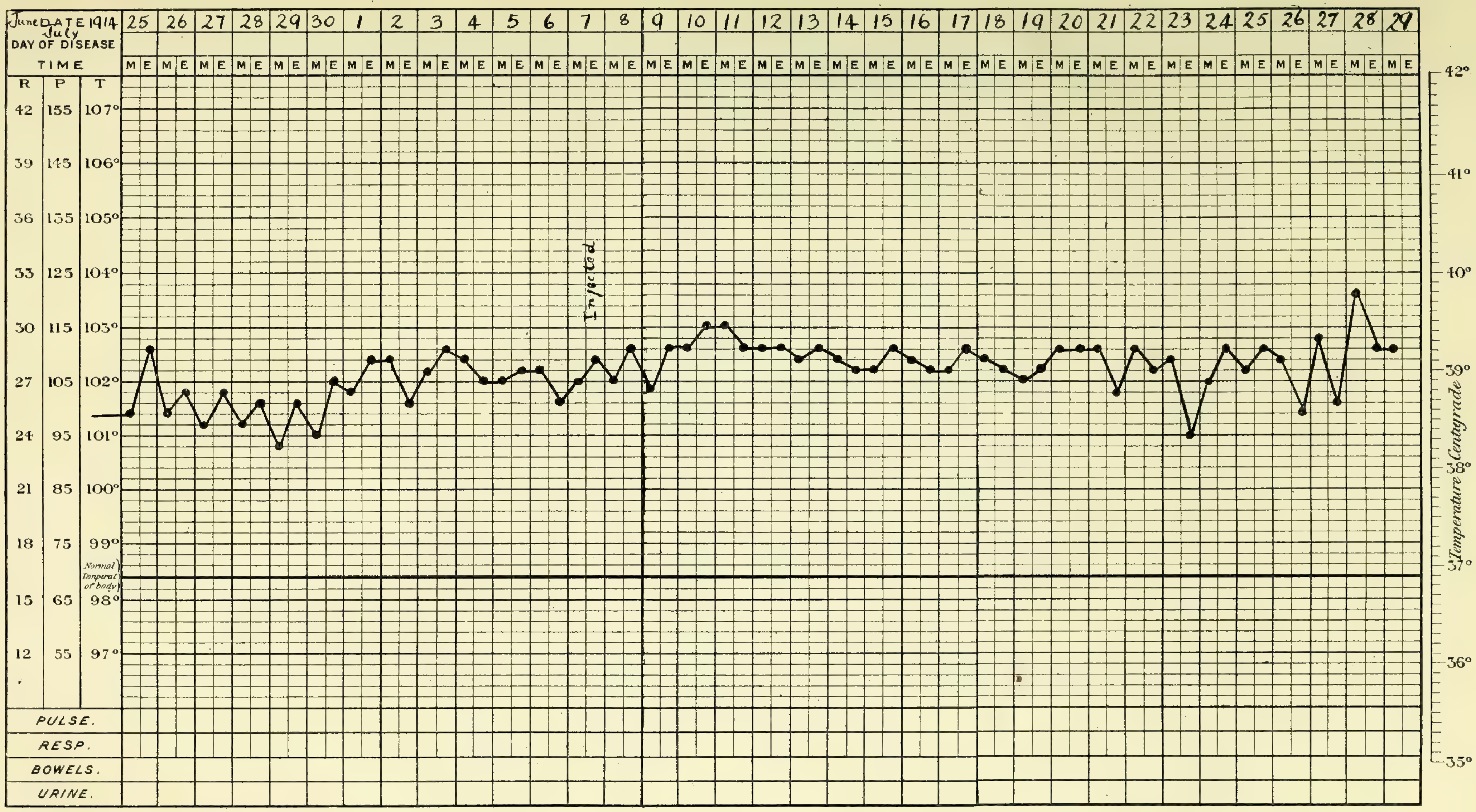

Chart 9. G.-p. 395, convalescent (4 months) after injection of yellow fever blood; injected from g.-p. 484 (natural infection).

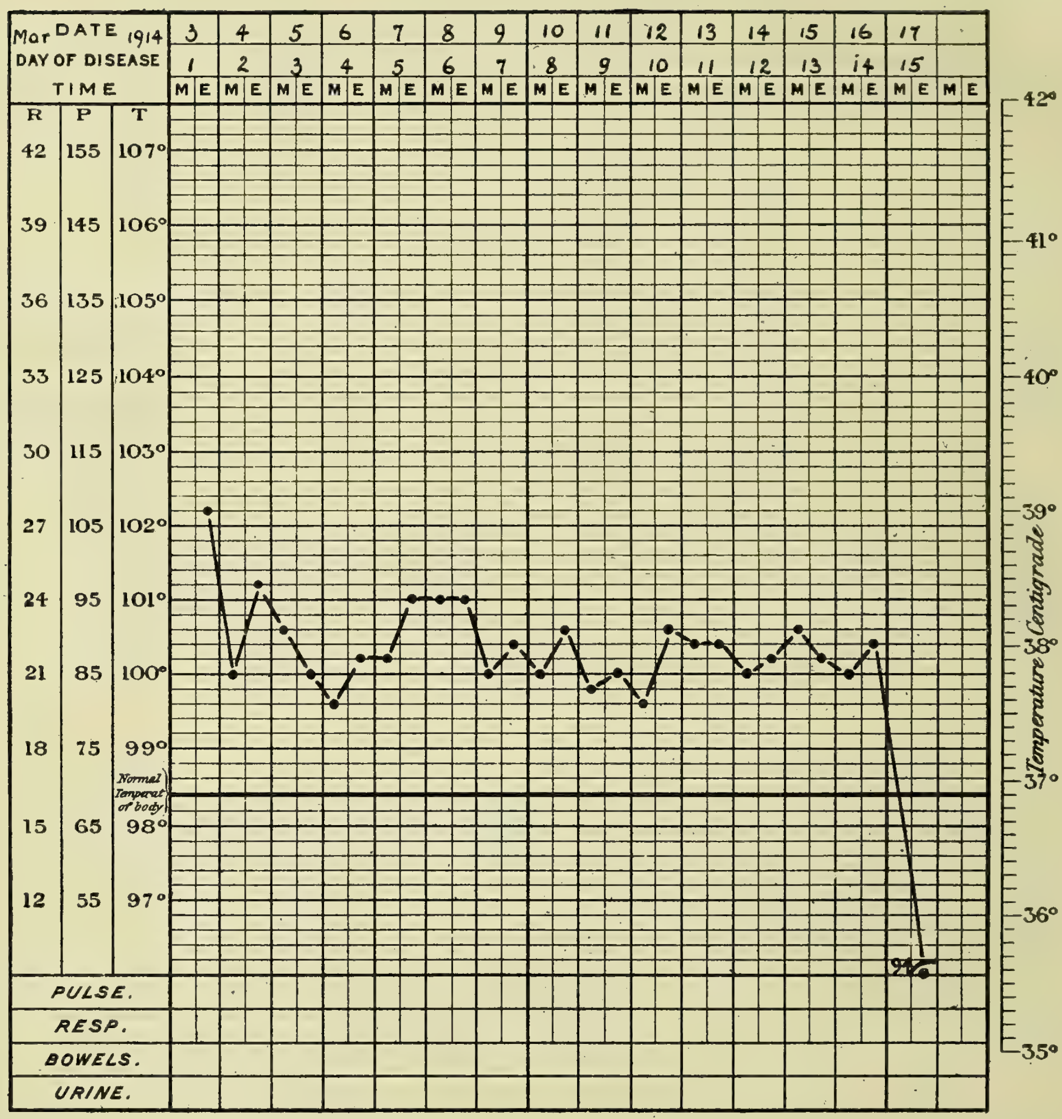

Chart 10. G.-p. 397, ? natural infection (supposed parasite found to be artefact).

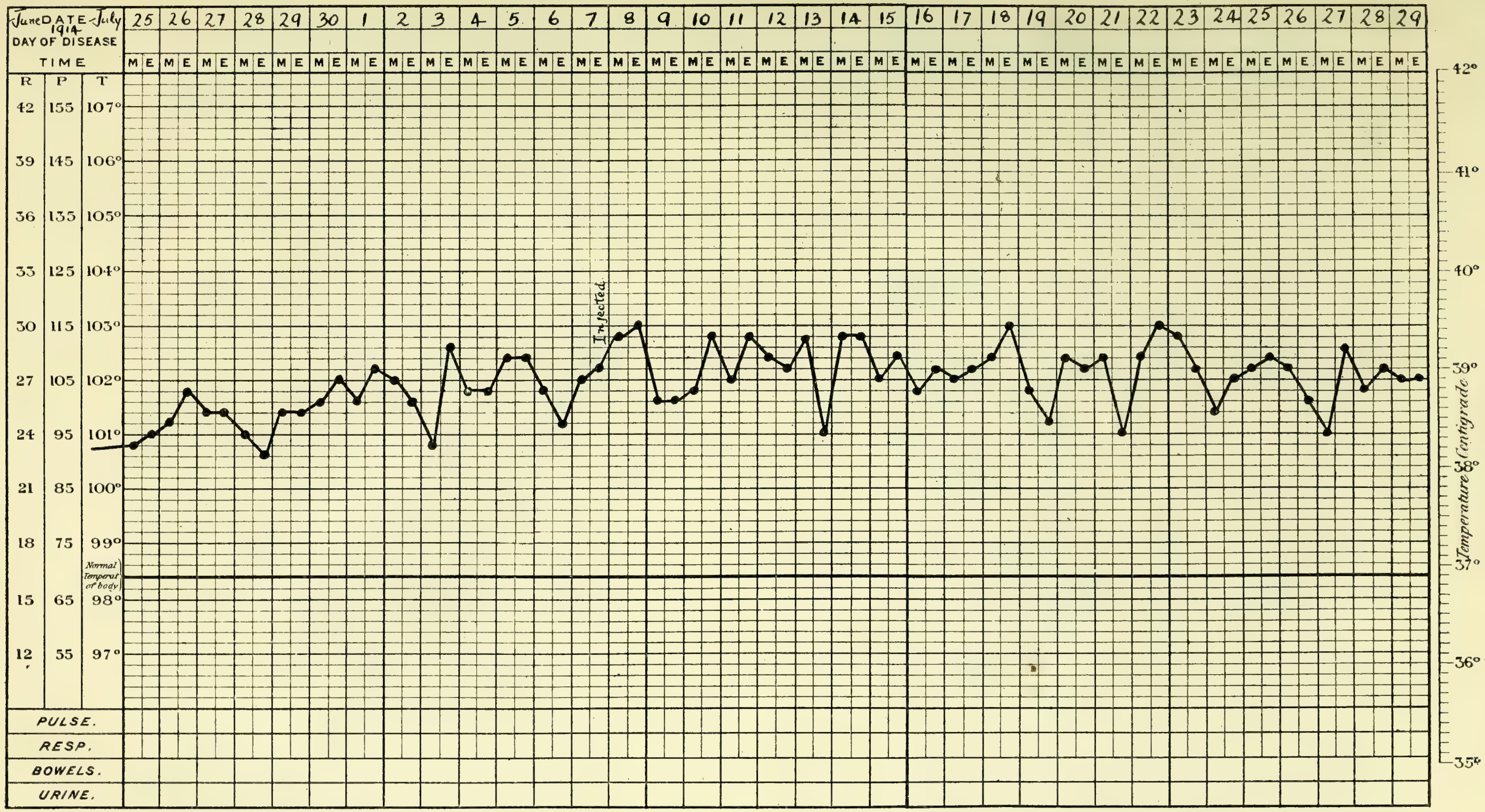

Chart 11. G.-p. 403, convalescent (4 months) after injection of yellow fever blood; injected from g.-p. 448 (natural infection).

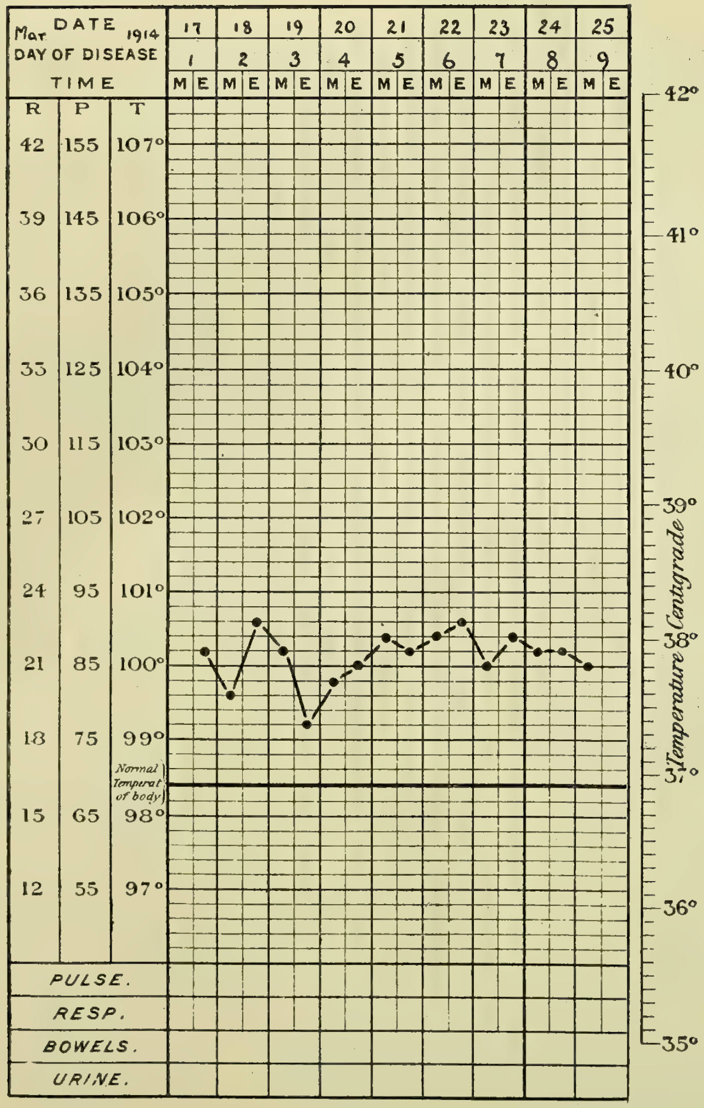

Chart 12. G.-p. 406, clean ; injected from g.-p. 397 (? natural infection).

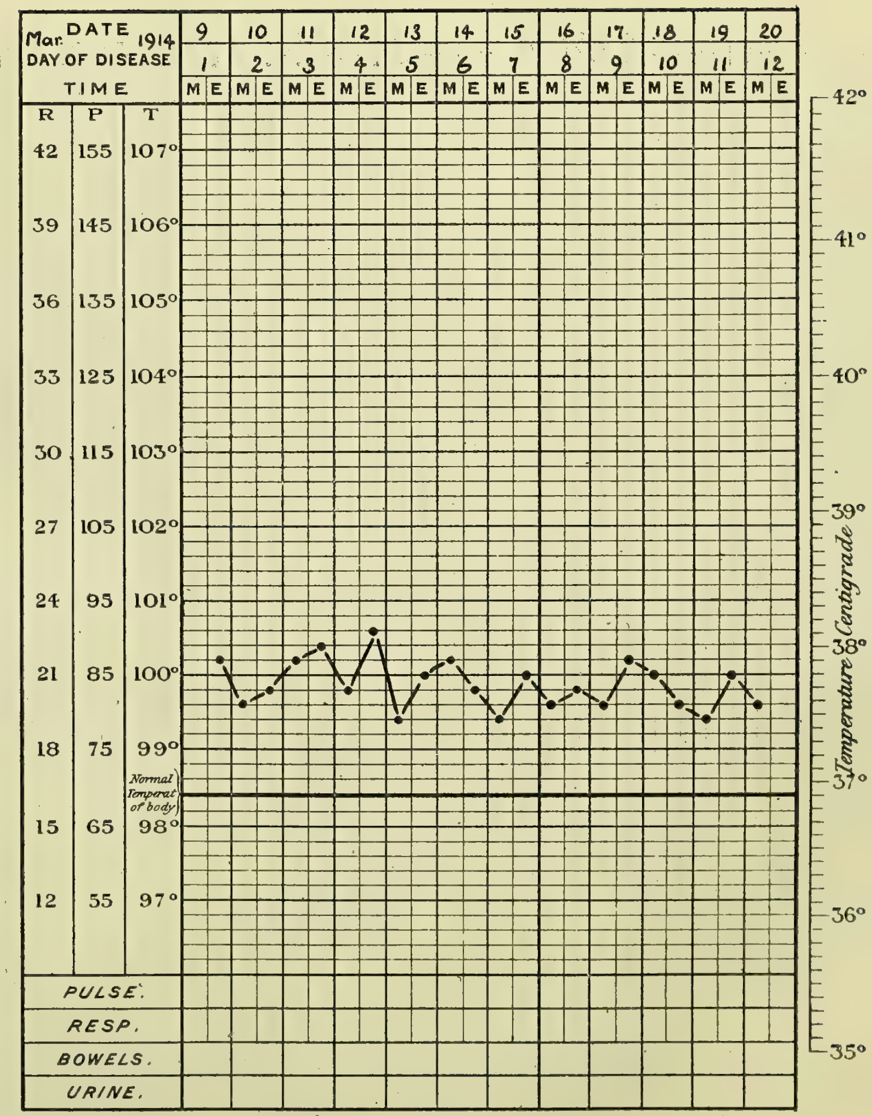

Chart 13. G.-p. 408, ? natural infection.

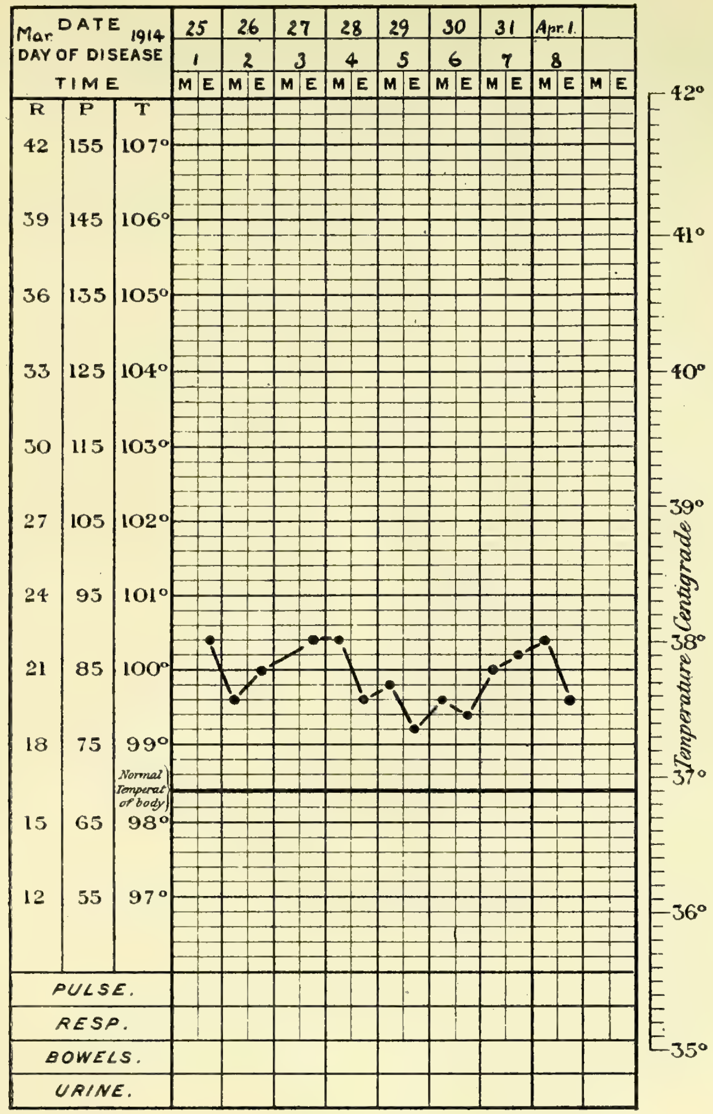

Chart 14. G.-p. 410, clean; injected from g.-p. 379 (? natural infection).

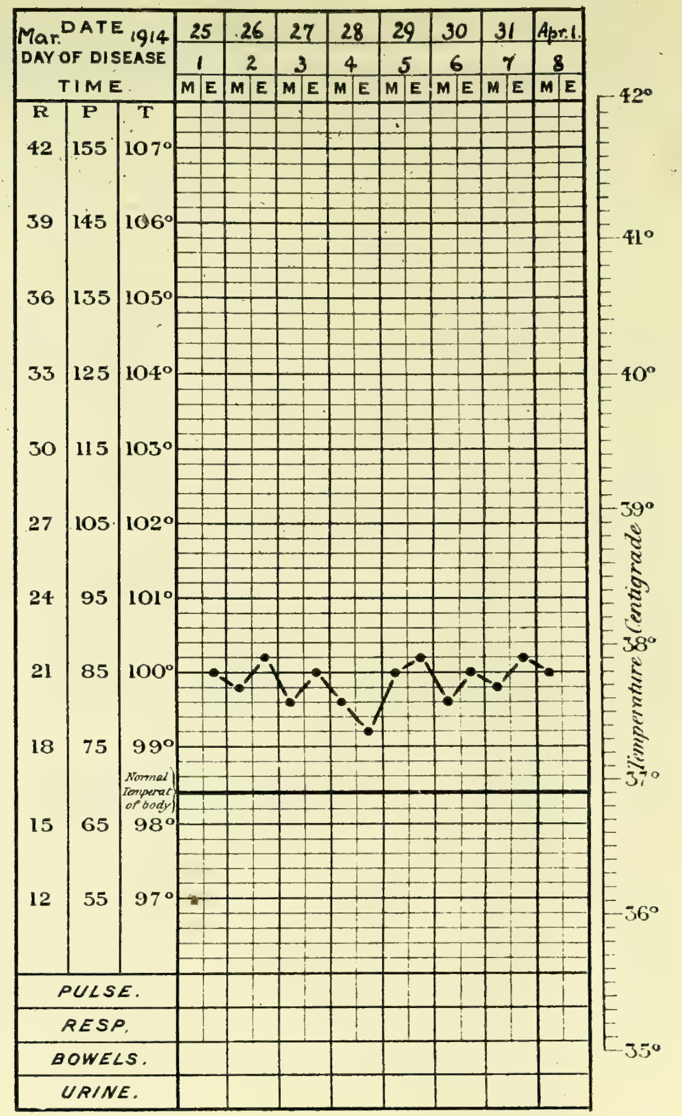

Chart 15. G.-p. 418, clean; injected from g.-p. 381 (? natural infection).

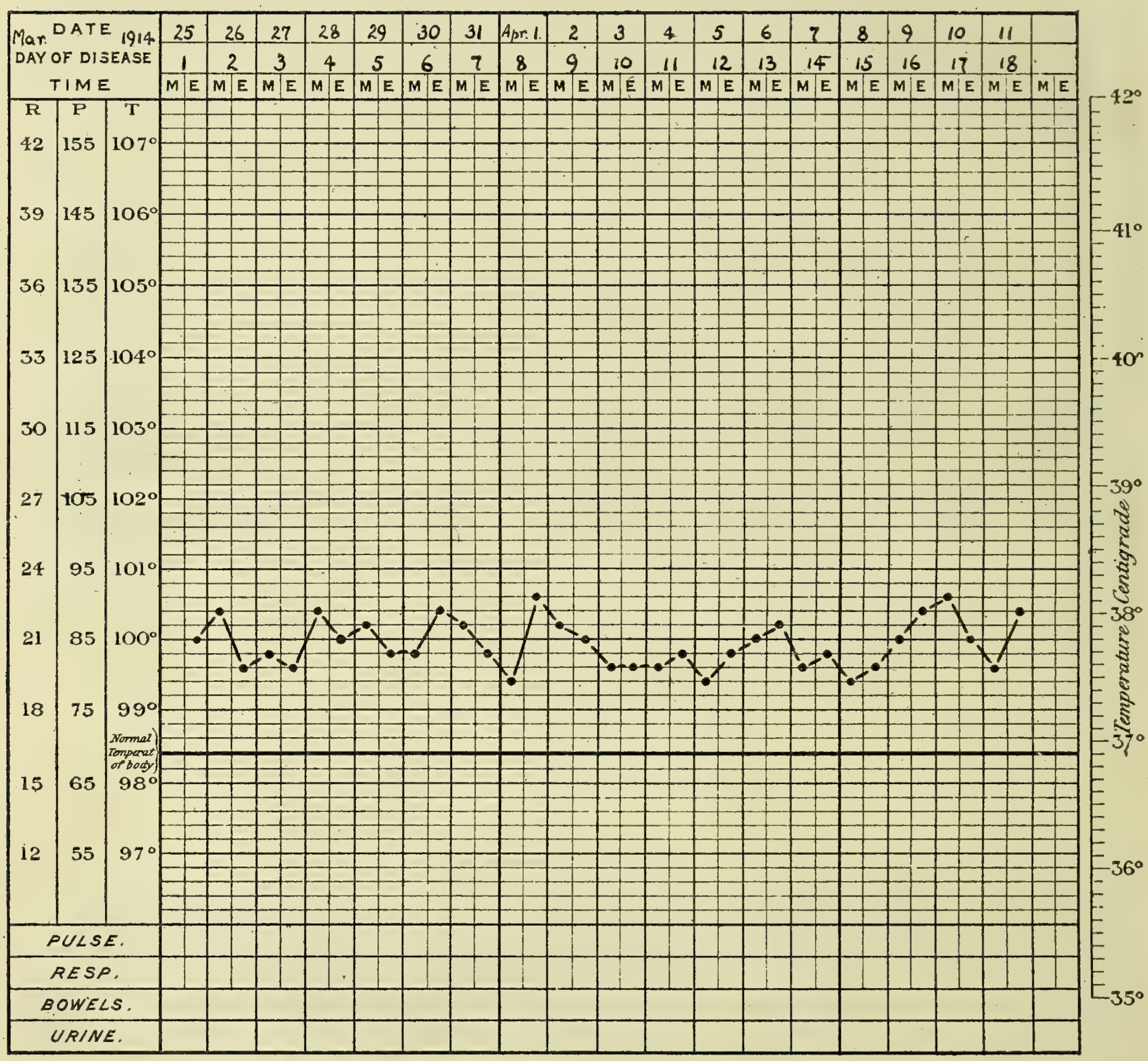

Chart 16. G.-p. 424, natural infection.

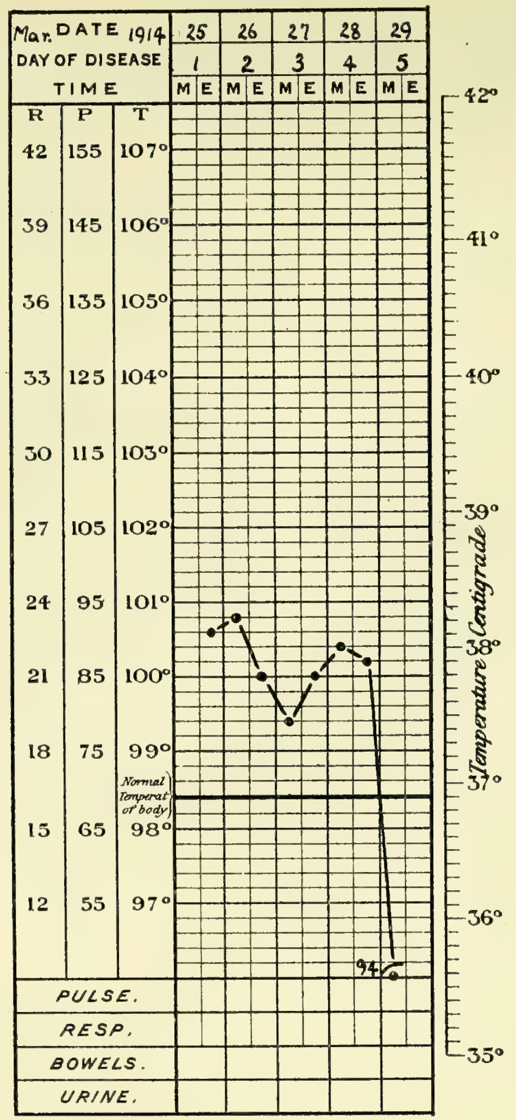

Chart 17. G.-p. 426, injected from g.-p. 392 (natural infection).

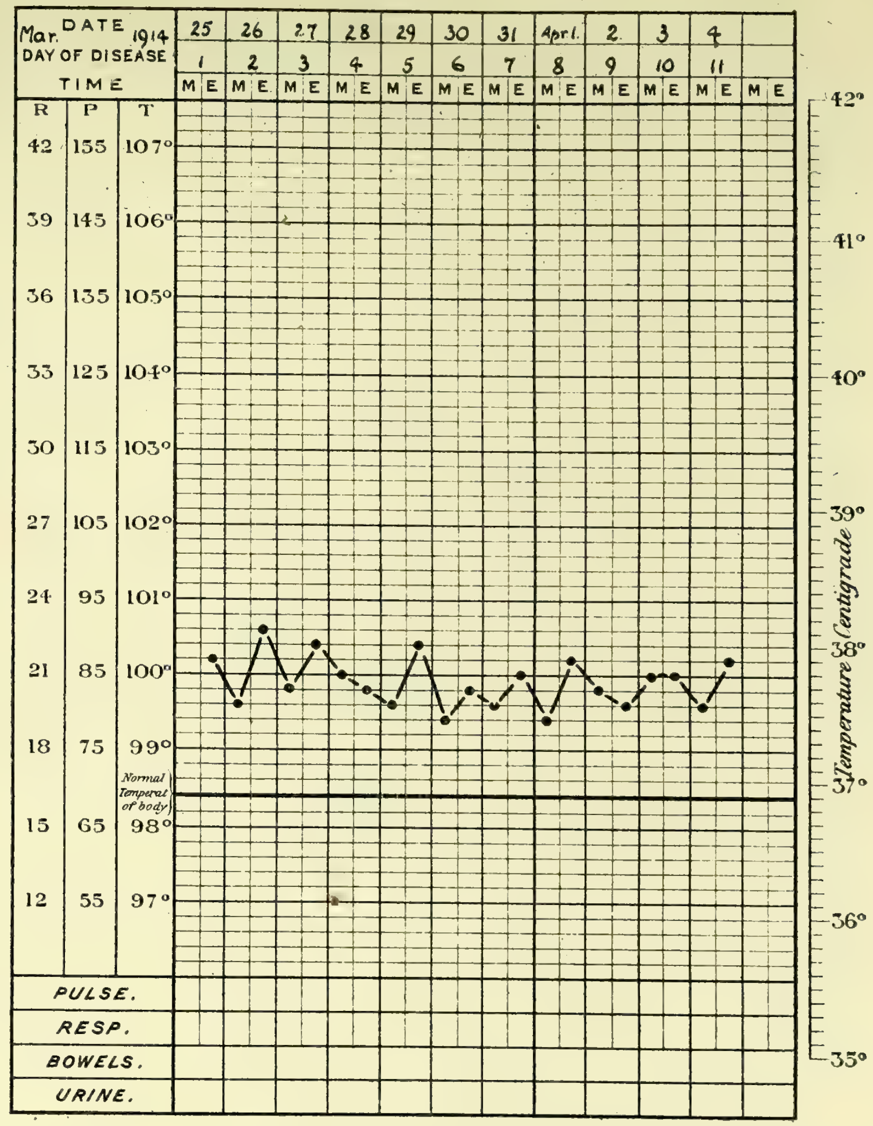

Chart 18. G.-p. 427 ; clean ; injected from g.-p. 406, from g.-p. 397 (? natural infection).

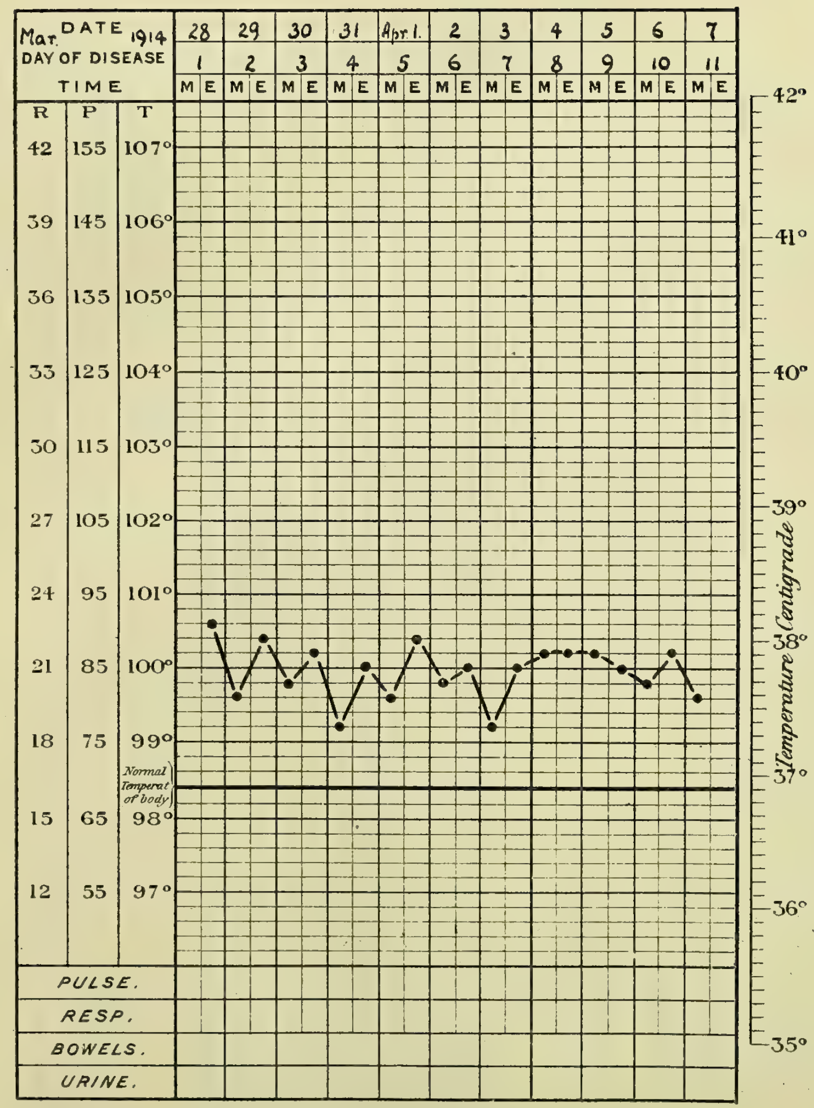

Chart 19. G.-p. 428 ; clean ; injected from g.-p. 426, from g.-p. 392 (? natural infection).

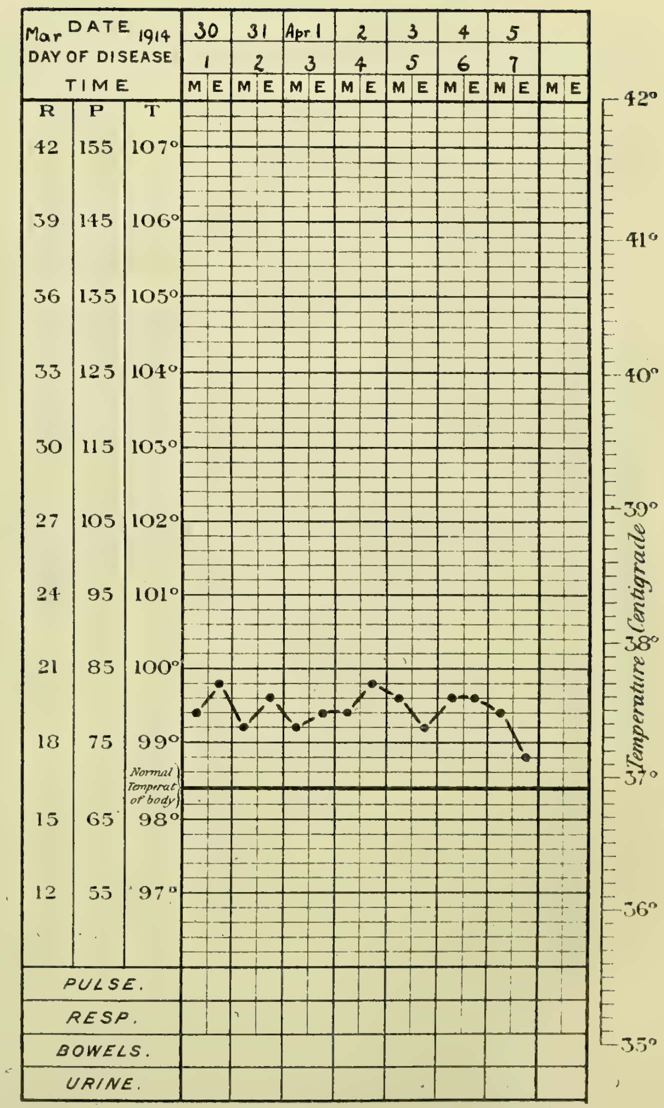

Chart 20. G.-p. 431, natural infection.

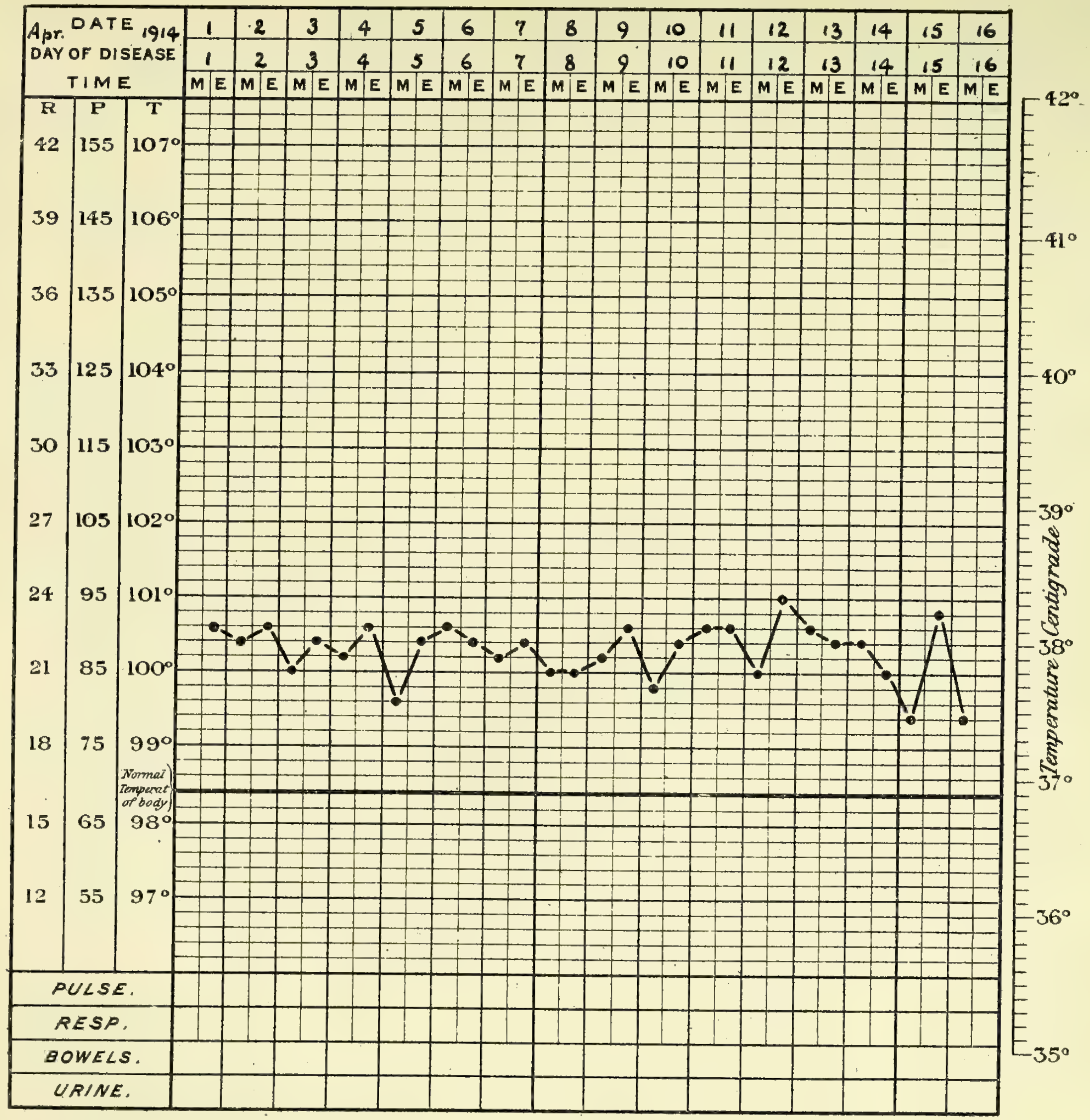

Chart 21. G.-p. 433, clean; injected from g.-p. 410, from g.-p. 379 (natural infection).

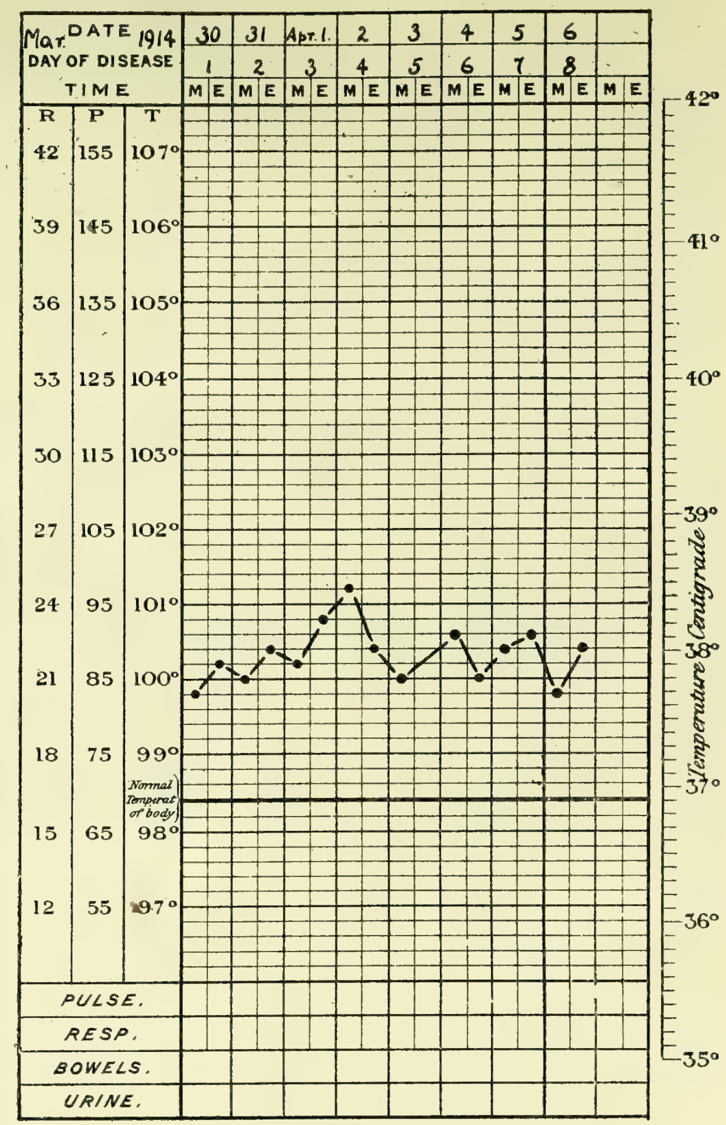

Chart 22. G.-p. 434, ? natural infection (supposed parasite found to be artefact).

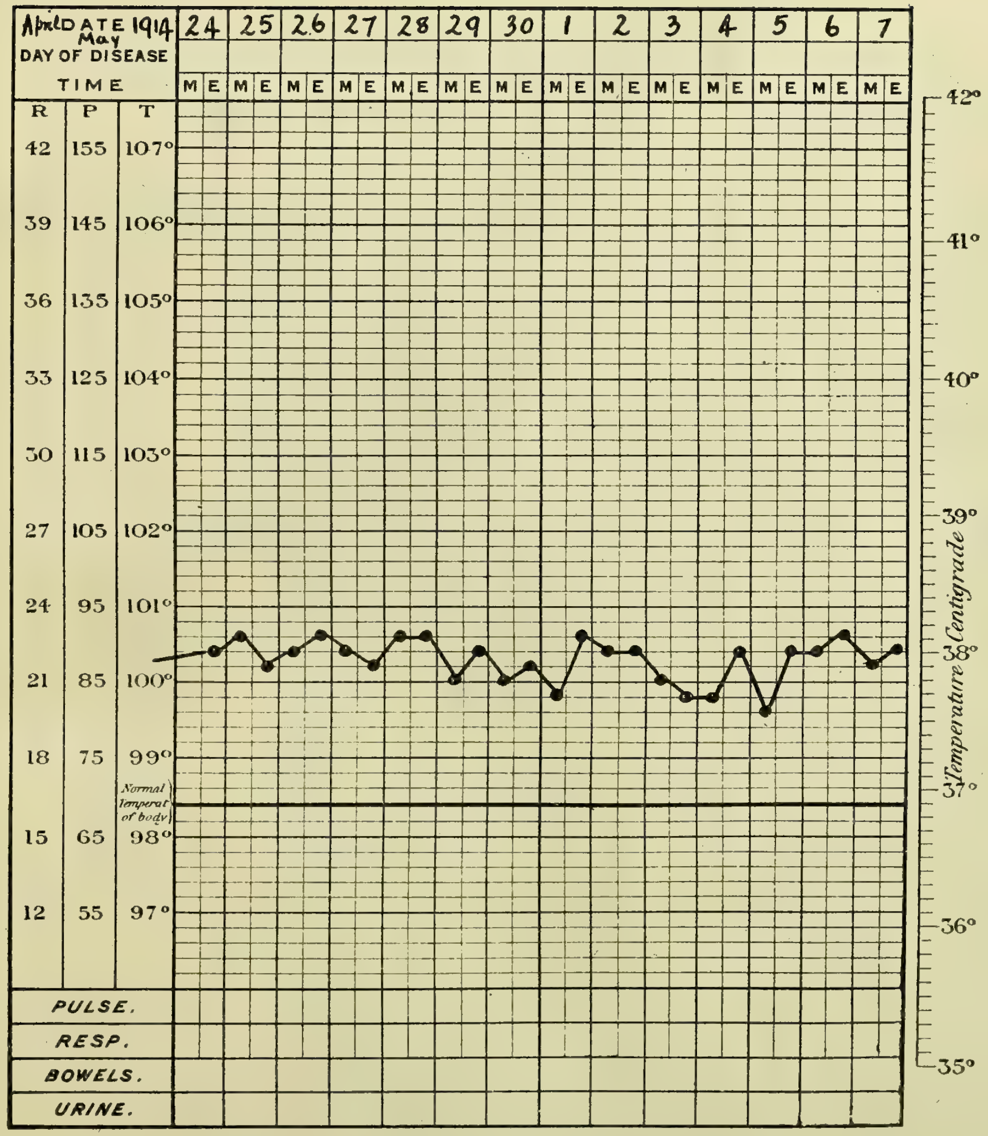

Chart 23. G.-p. 439, natural infection.

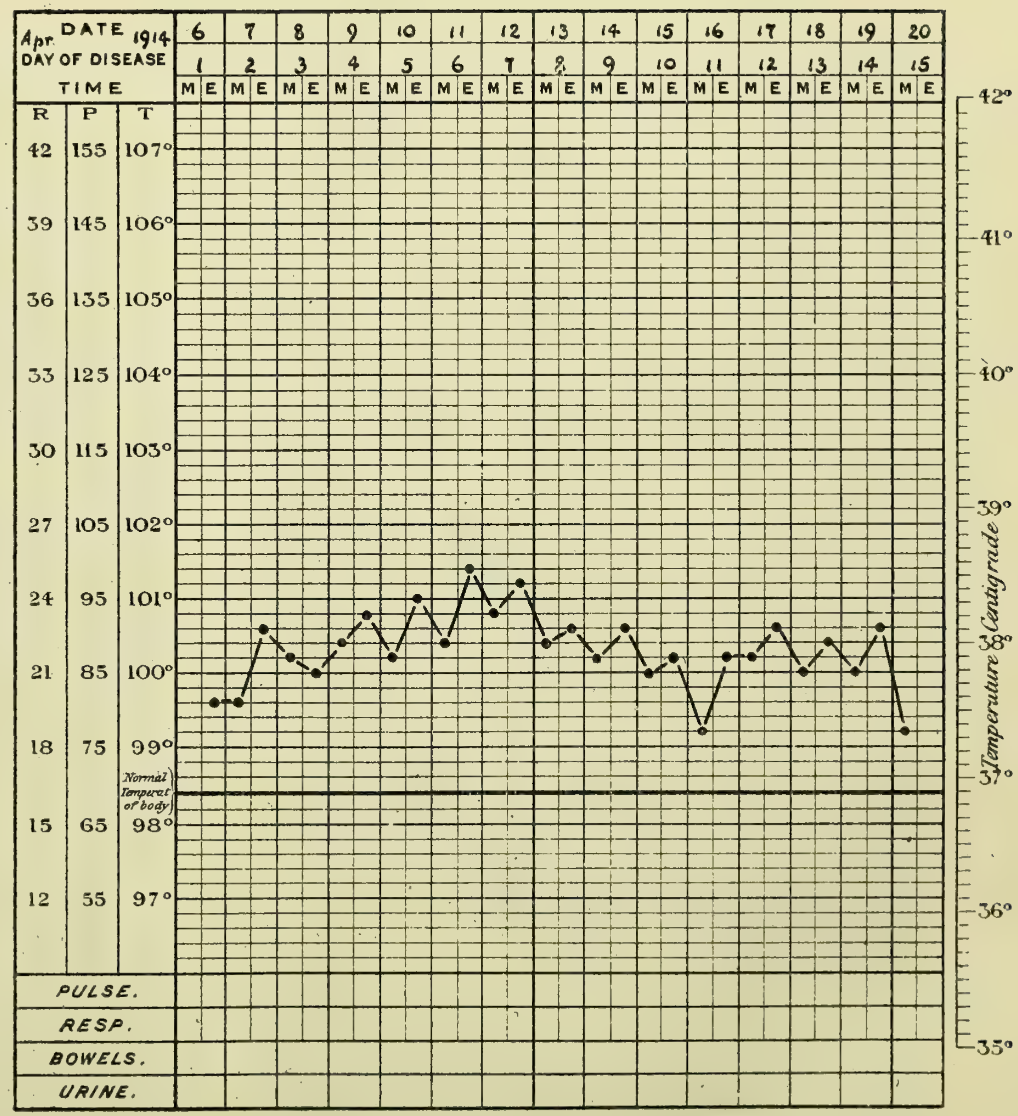

Chart 24. G.-p. 443, clean; injected from 434 (? natural infection).

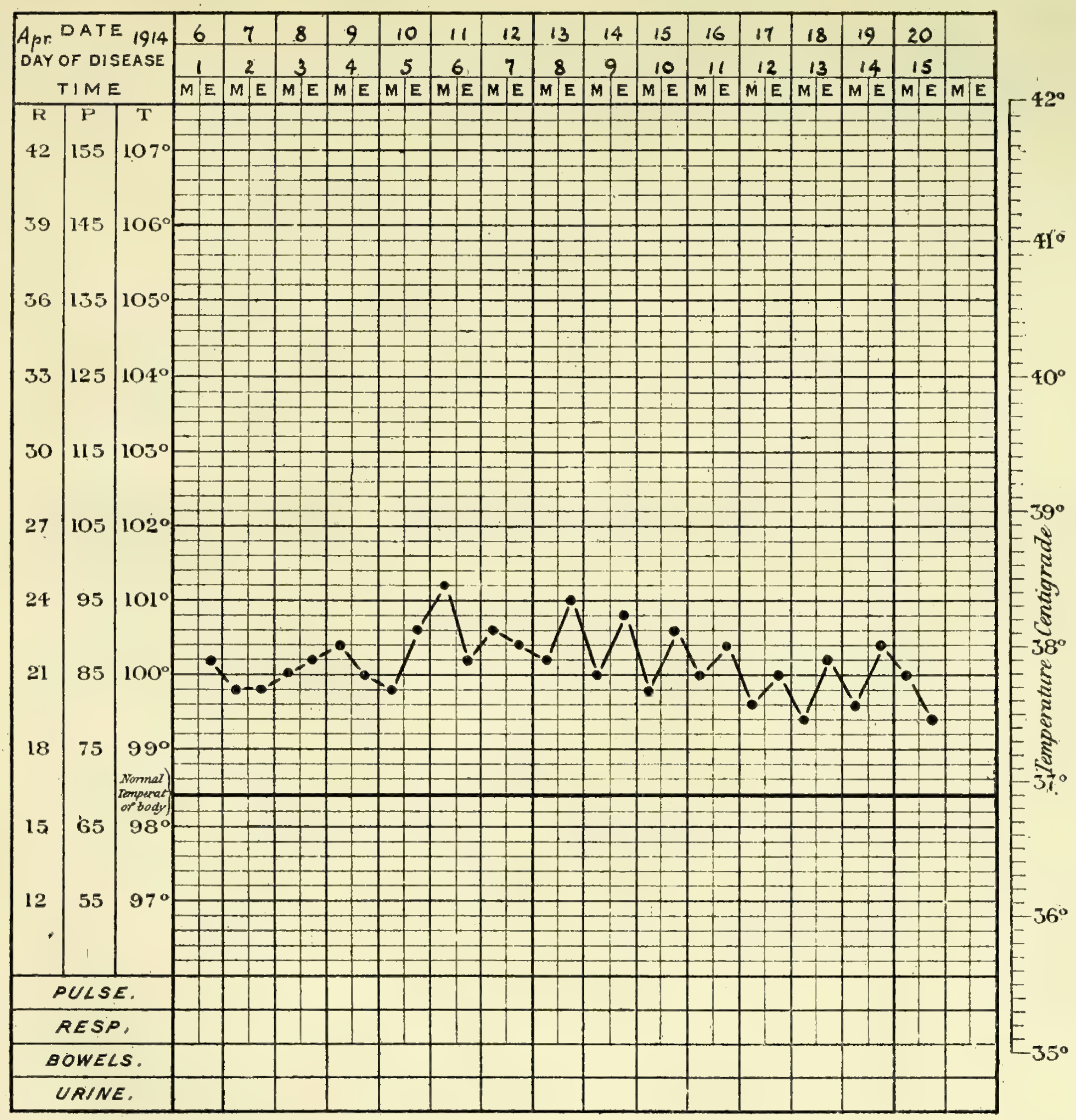

Chart 25. G.-p. 444, clean; injected from g.-p. 431 (natural infection).

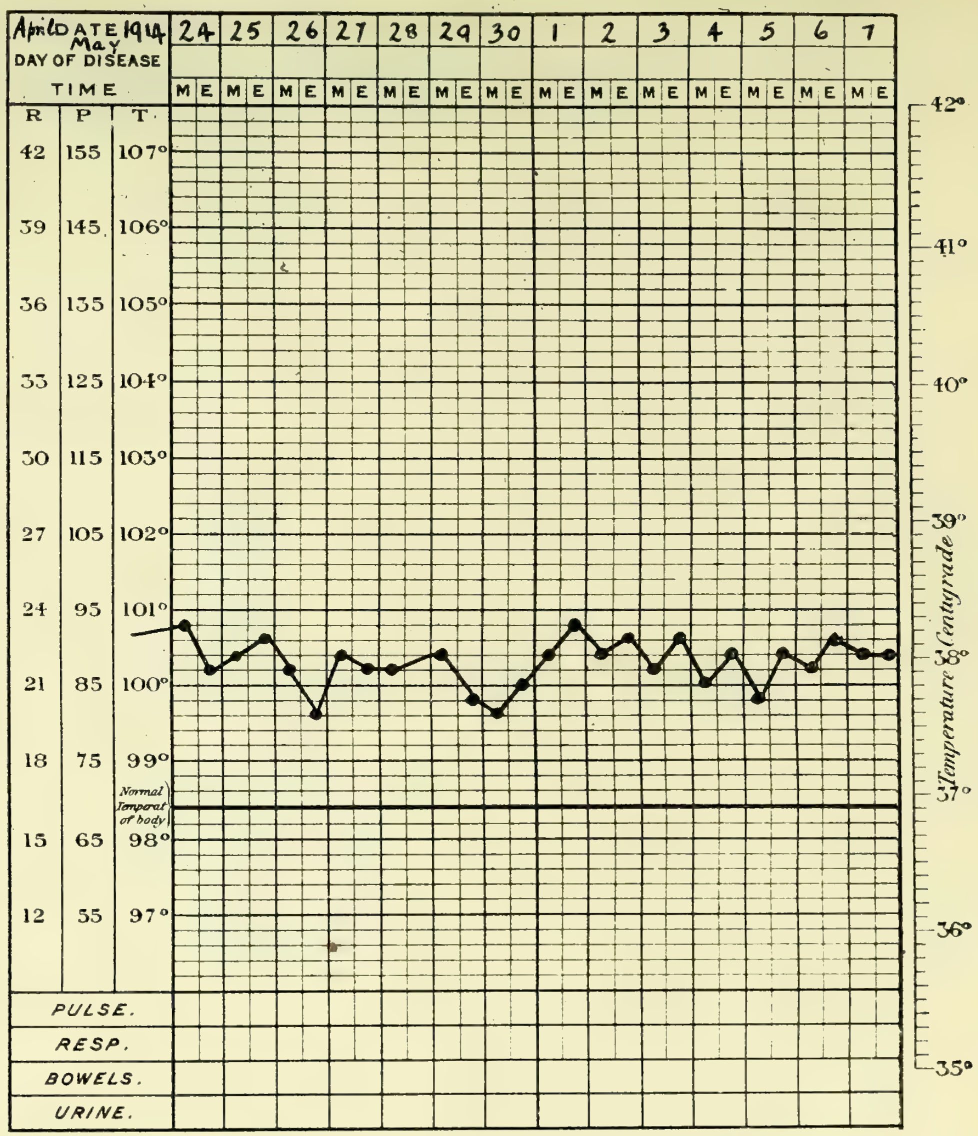

Chart 26. G.-p. 446, natural infection.

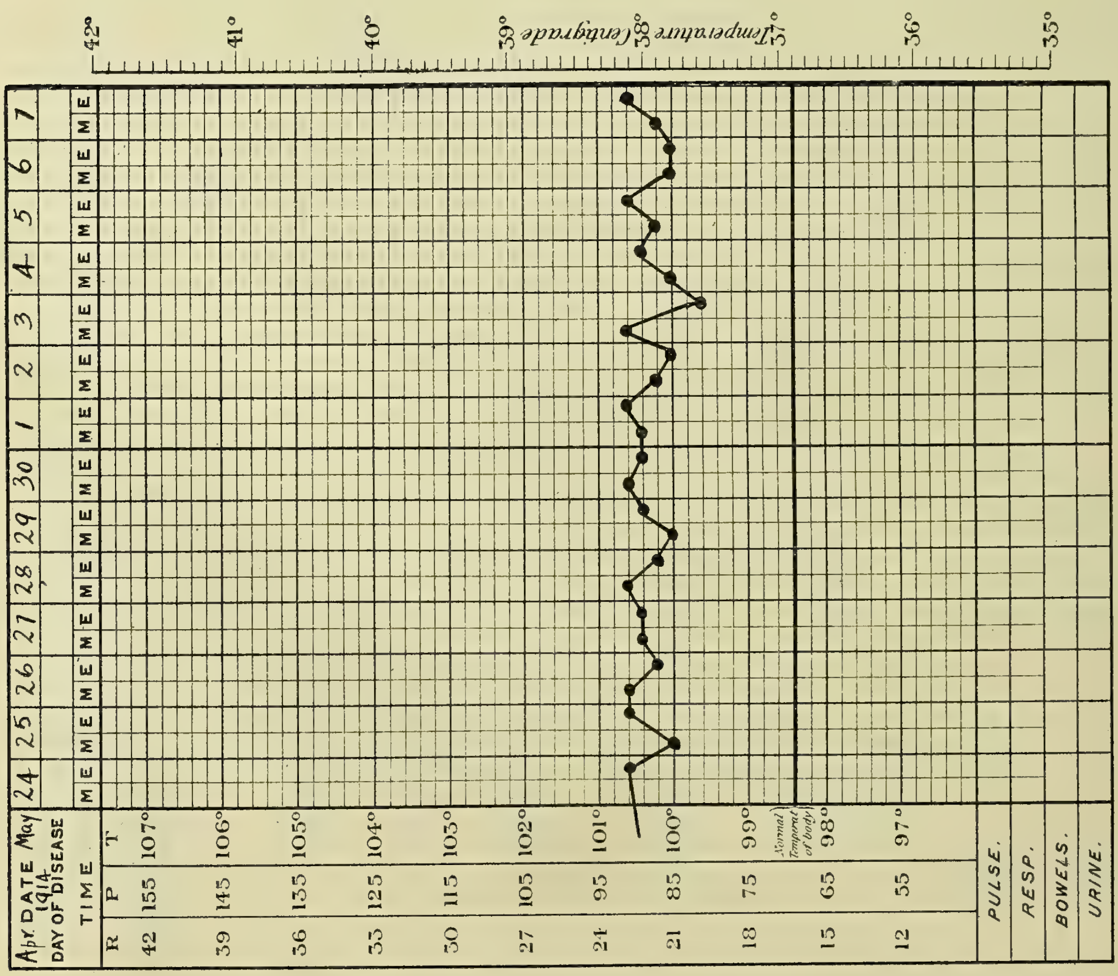

Chart 29. G.-p. 452, natural infection.

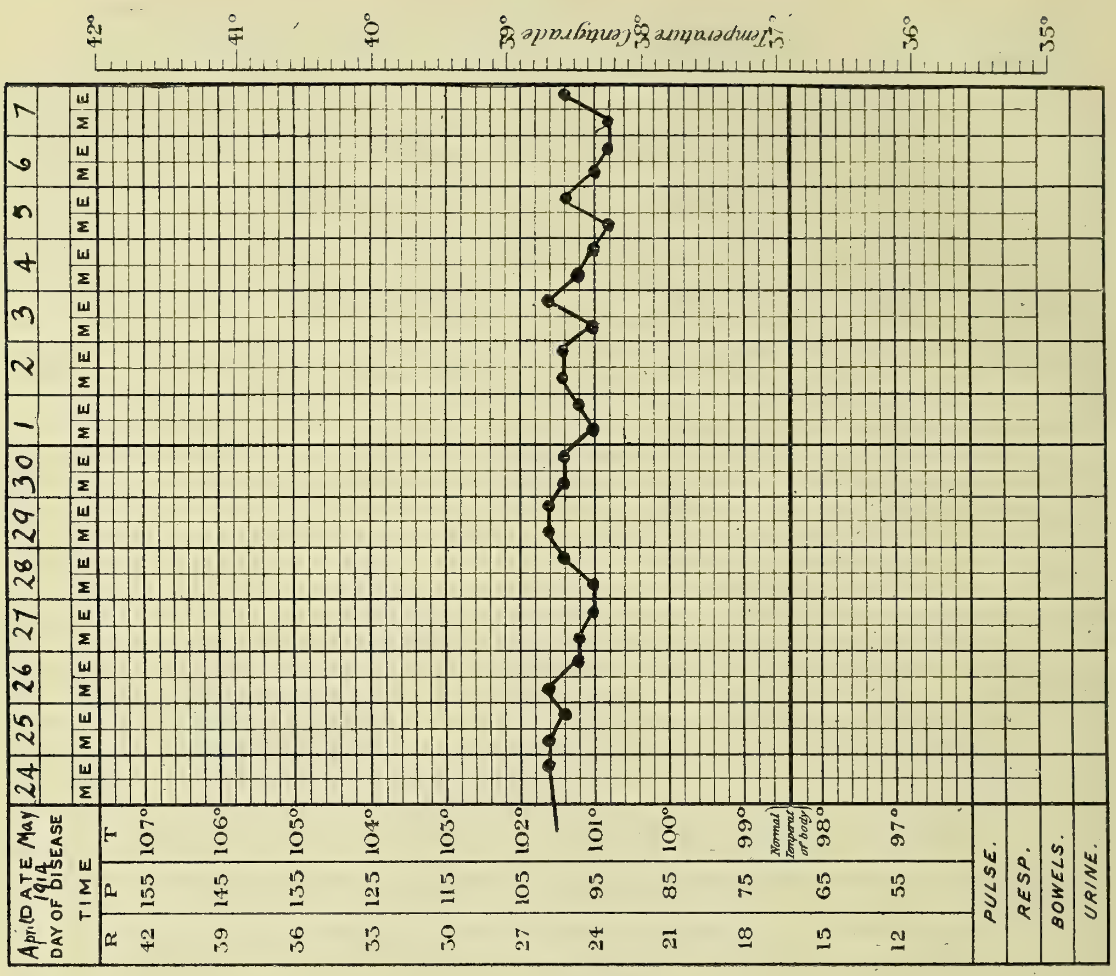

Chart 30. G.-p. 454, natural infection

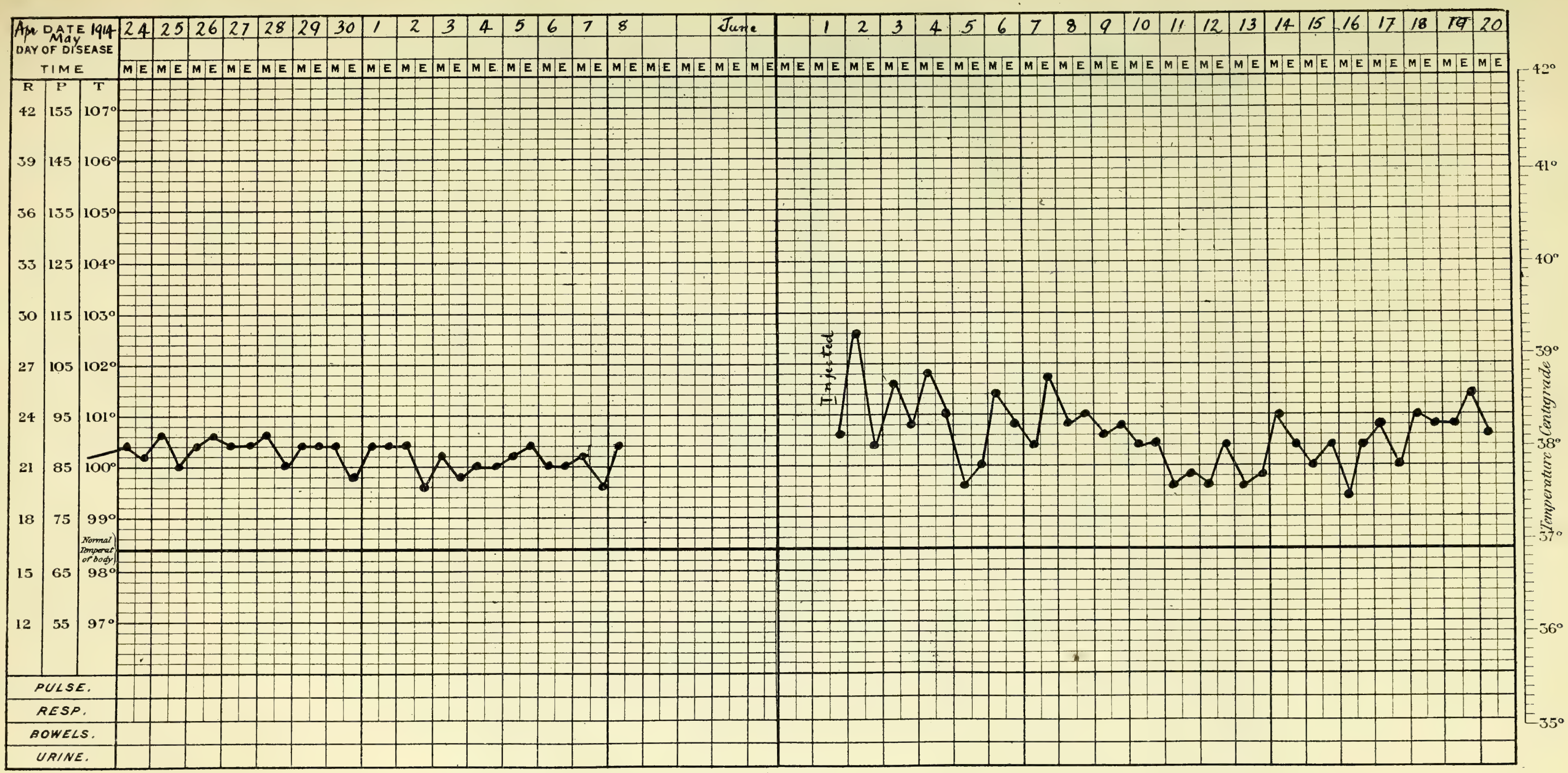

Chart 31. G.-p. 455; natural infection (parasites found once in 7 examinations); injected with normal blood (Negro).

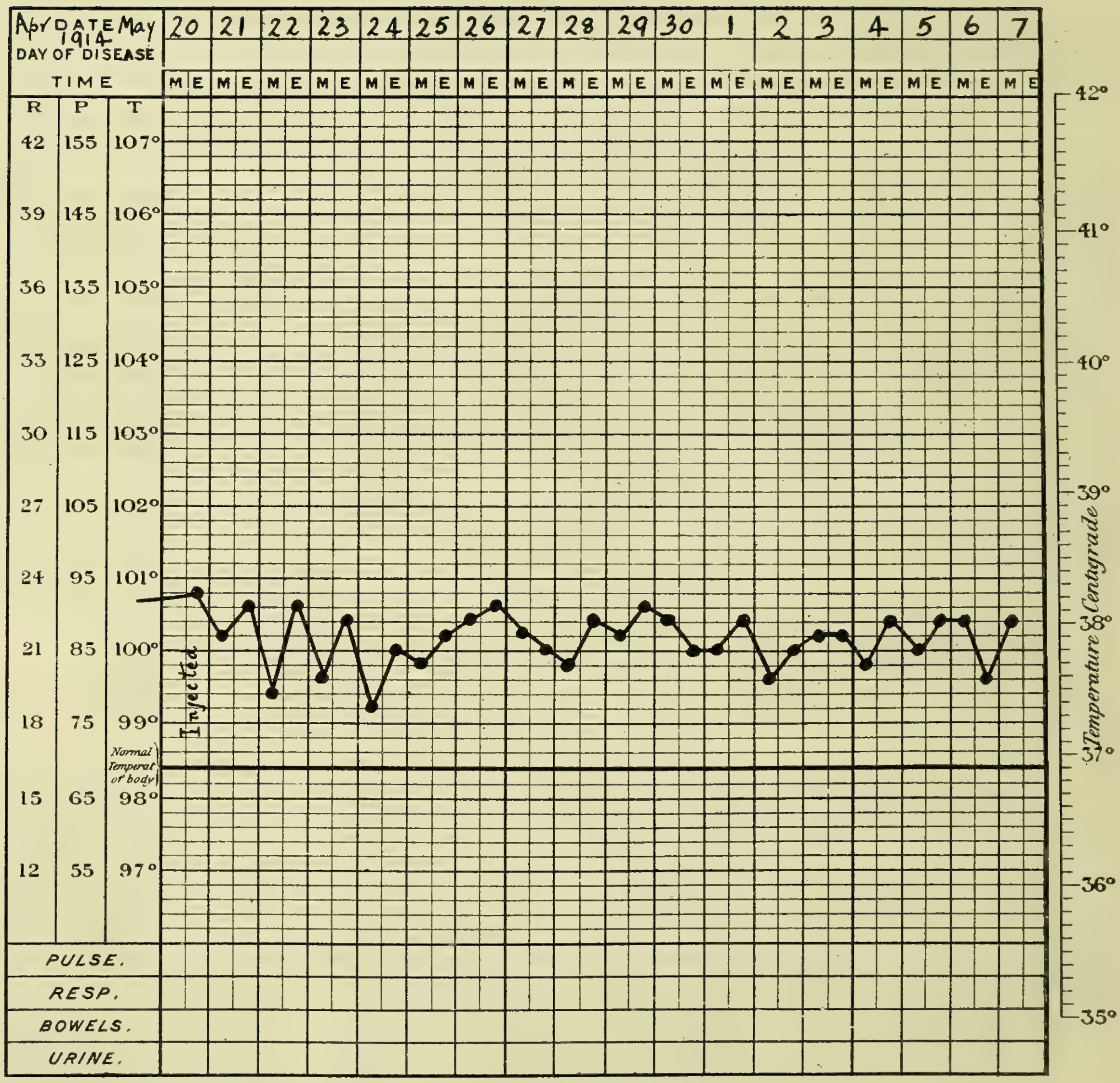

Chart 32. G.-p. 456, subinoculated from g.-p. 433, from g.-p. 410, from g.-p. 379 (natural infection).

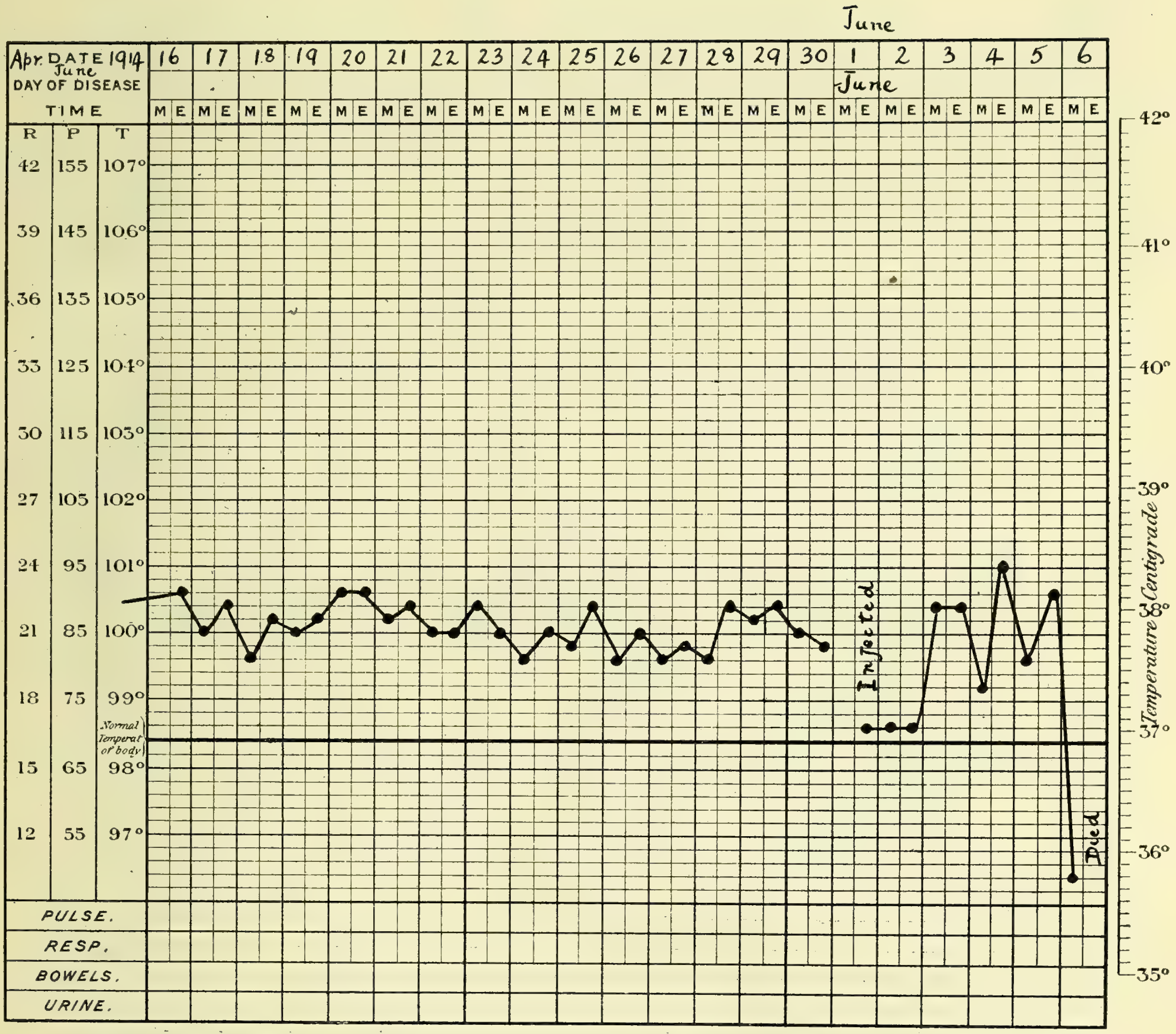

Chart 33. G.-p. 458, natural infection; injected with normal blood (Negro).

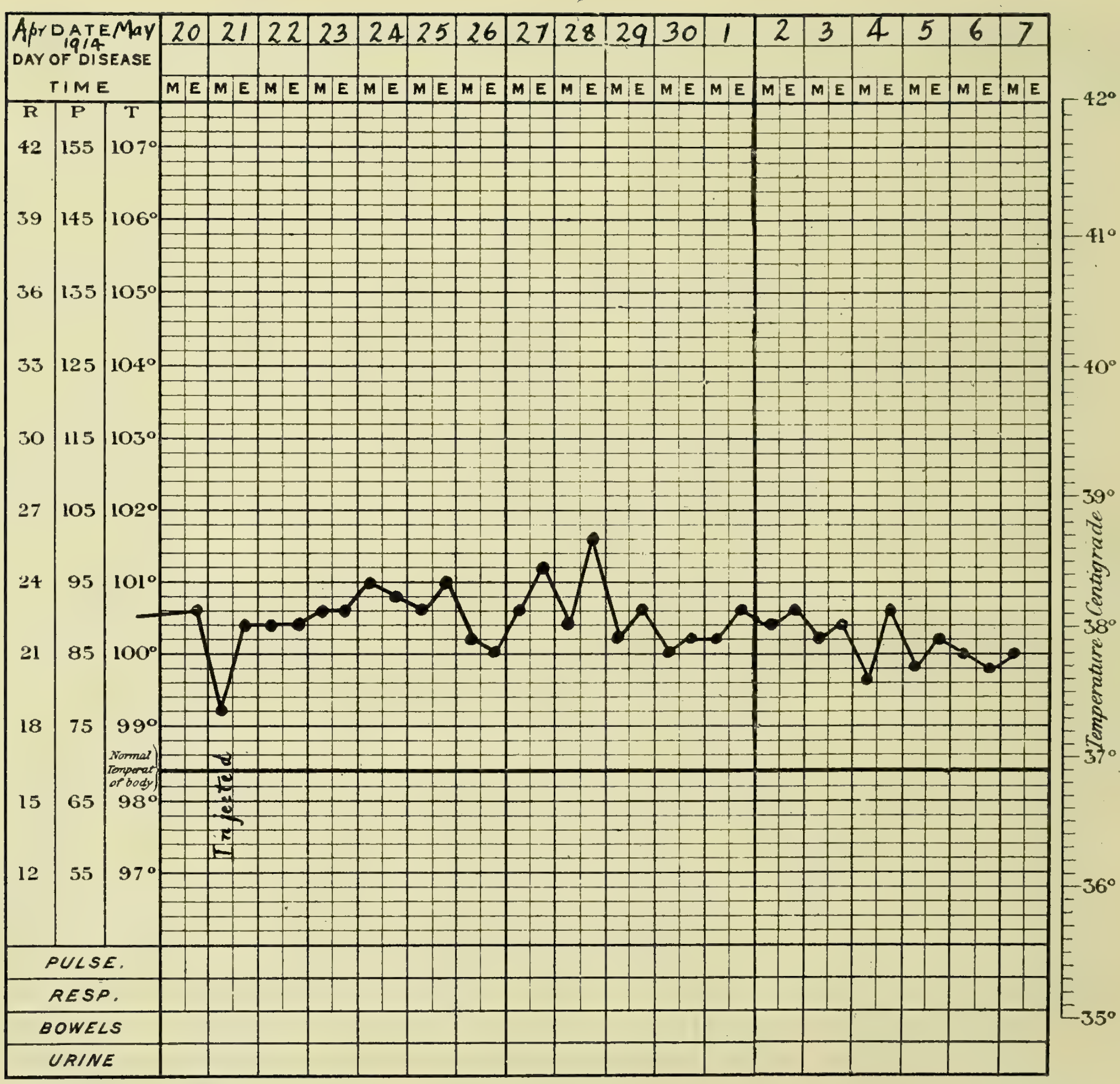

Chart 34. G.-p. 459, clean; sub-inoculated from g.-p. 443, inoculated from g.-p. 434, natural infection.

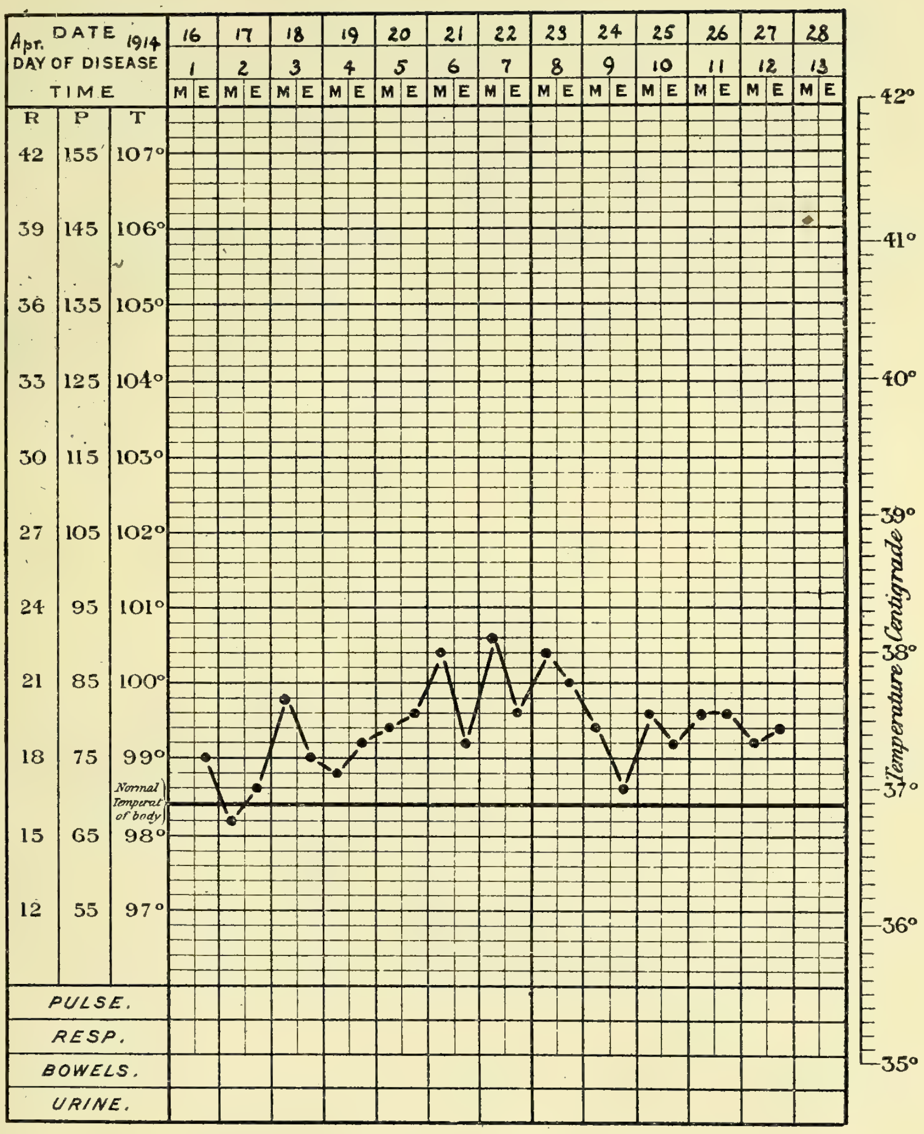

Chart 35. Rat 461, injected from G.-p. 458 (natural infection).

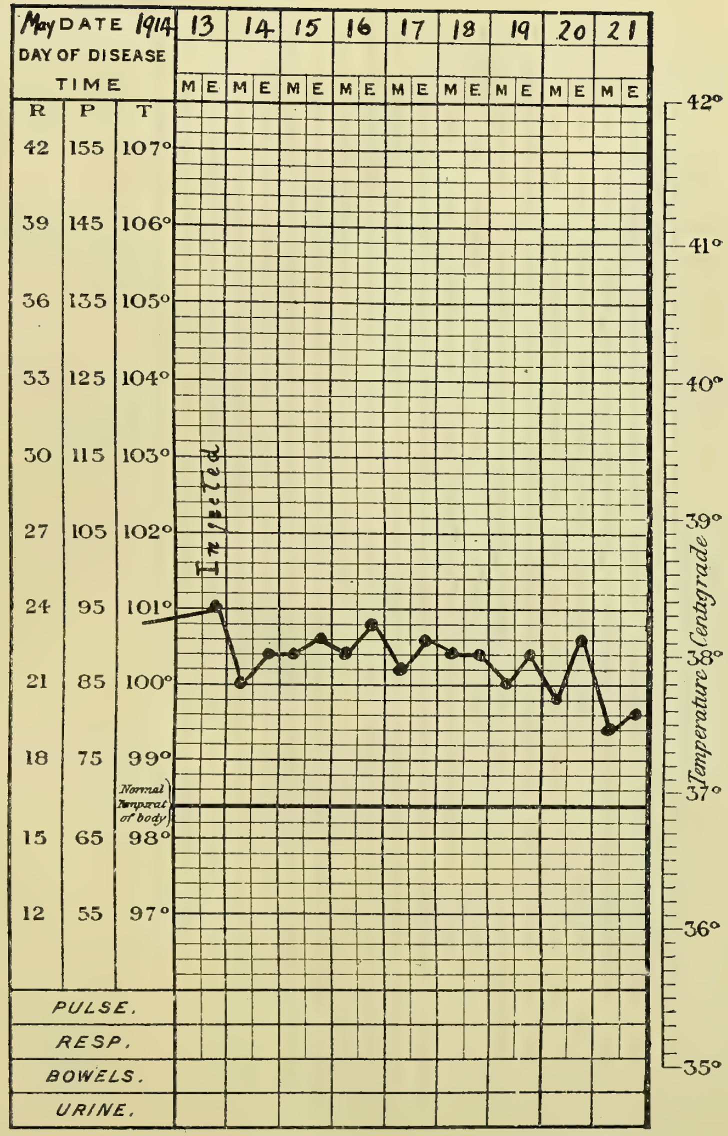

Chart 36. G.-p. 464, clean; injected with normal blood (European).

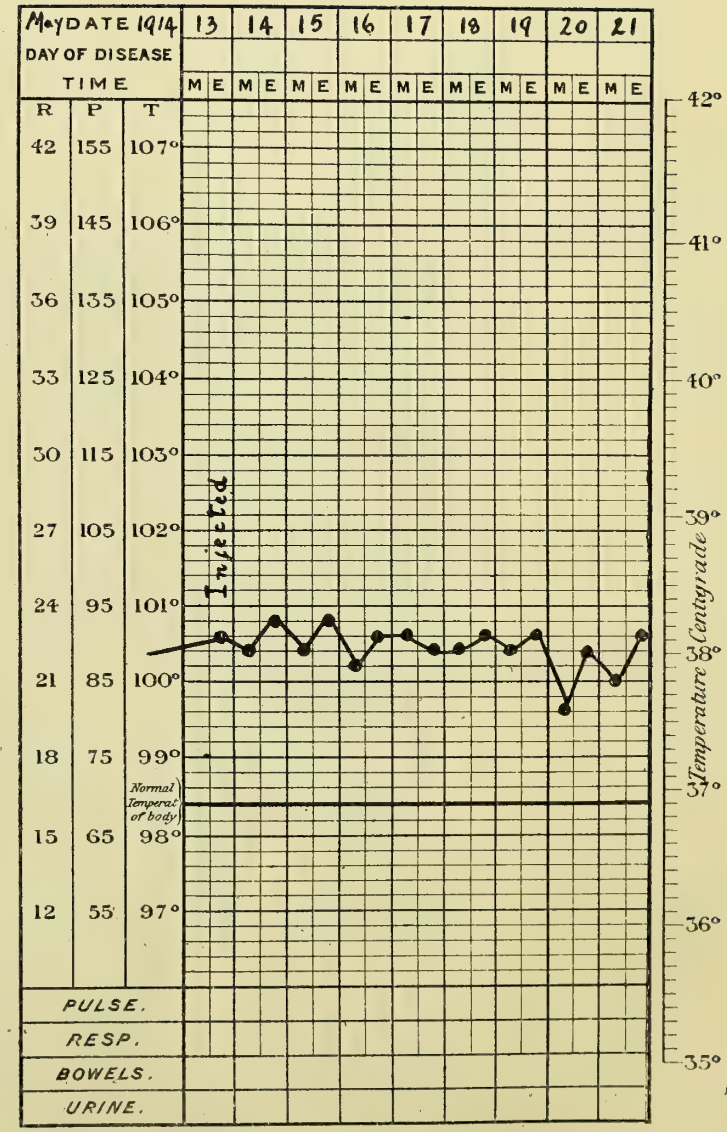

Chart 37. G.-p. 466, clean; injected with normal blood (European).

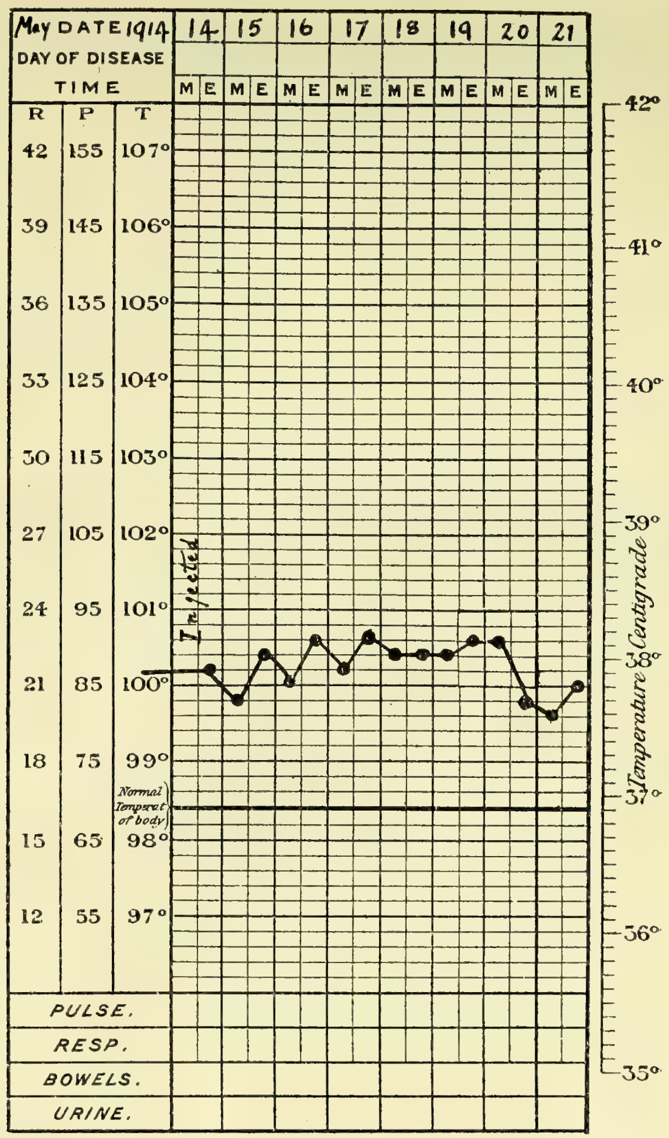

Chart 38. G.-p. 468, clean; injected with normal blood (European).

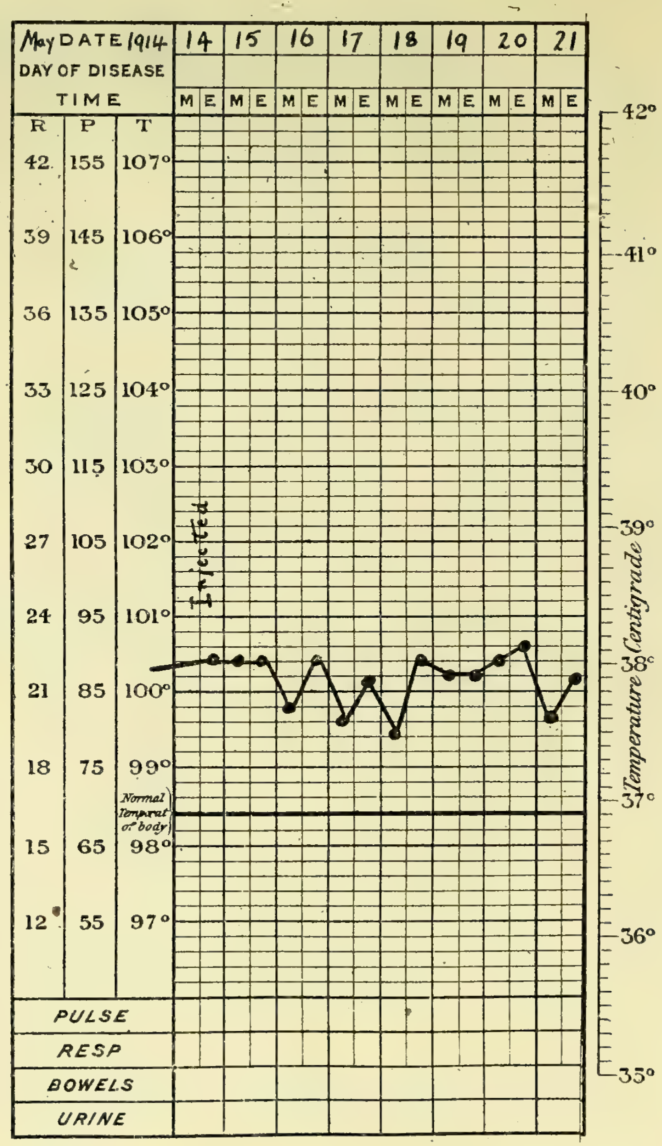

Chart 39. G.-p. 471, clean; injected with normal blood (European).

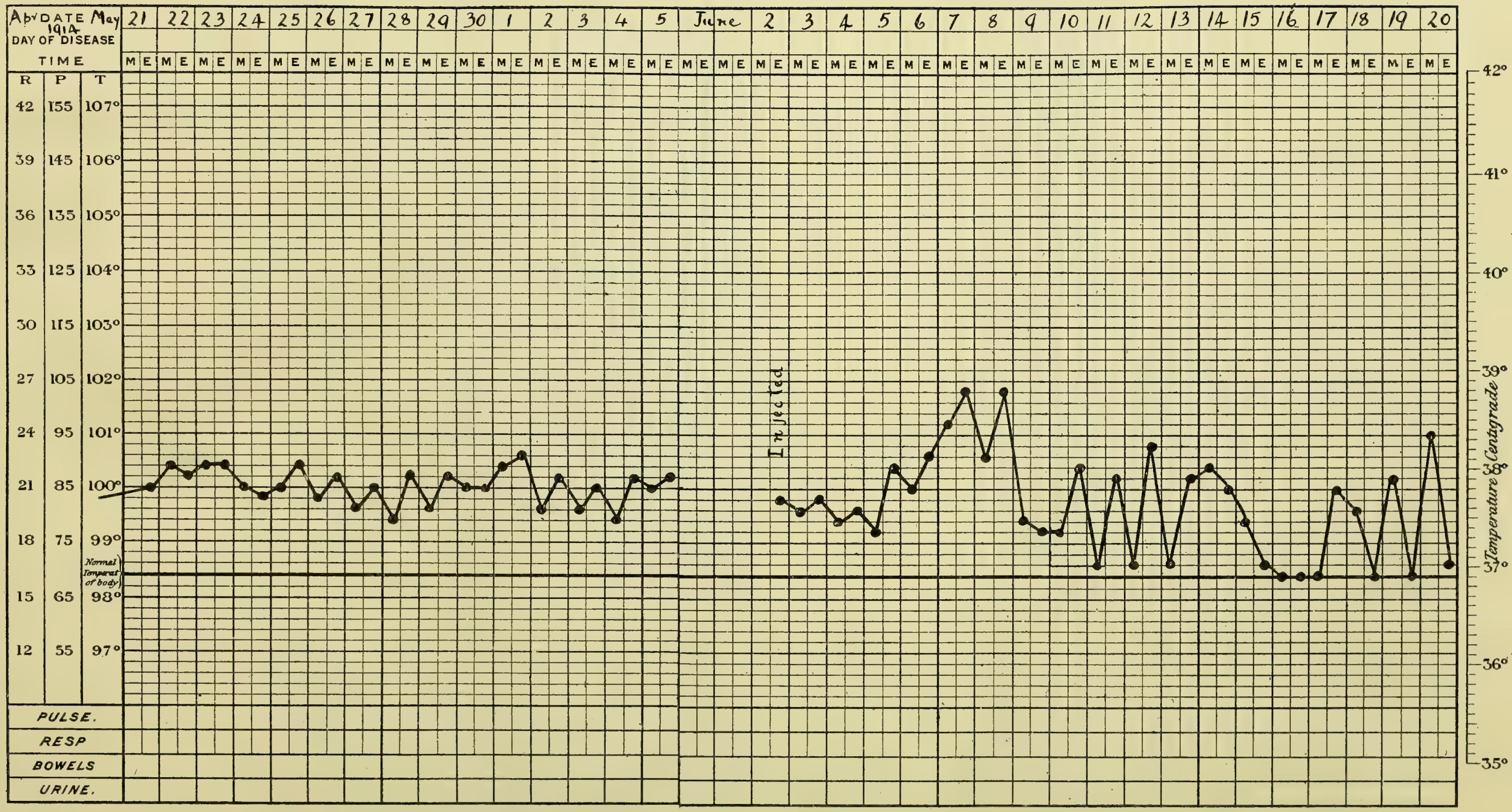

Chart 40. G.-p. 473, natural infection; injected with normal blood (Negro).

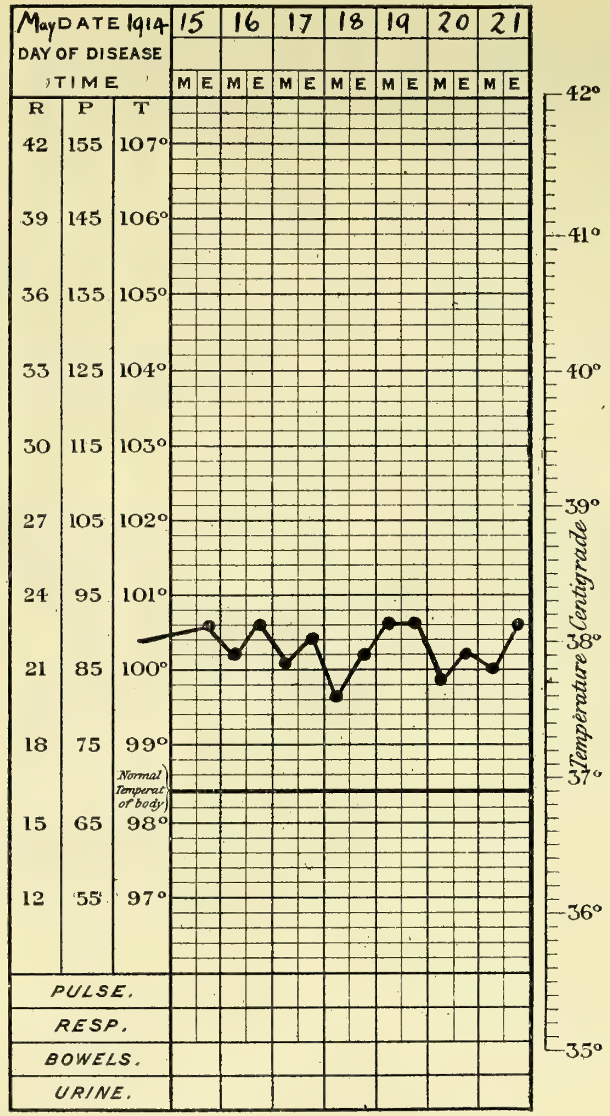

Chart 41. G.-p. 475, clean; injected with normal blood (European). Parasites found 20th May, 1914.

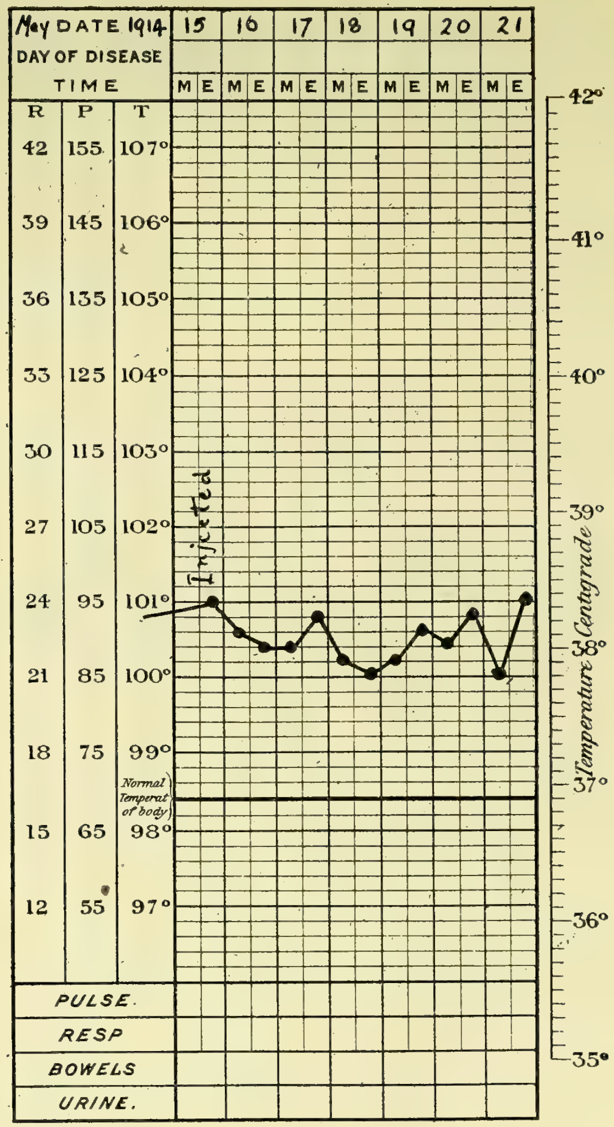

Chart 42. G.-p. 476, clean; injected with normal blood (European).

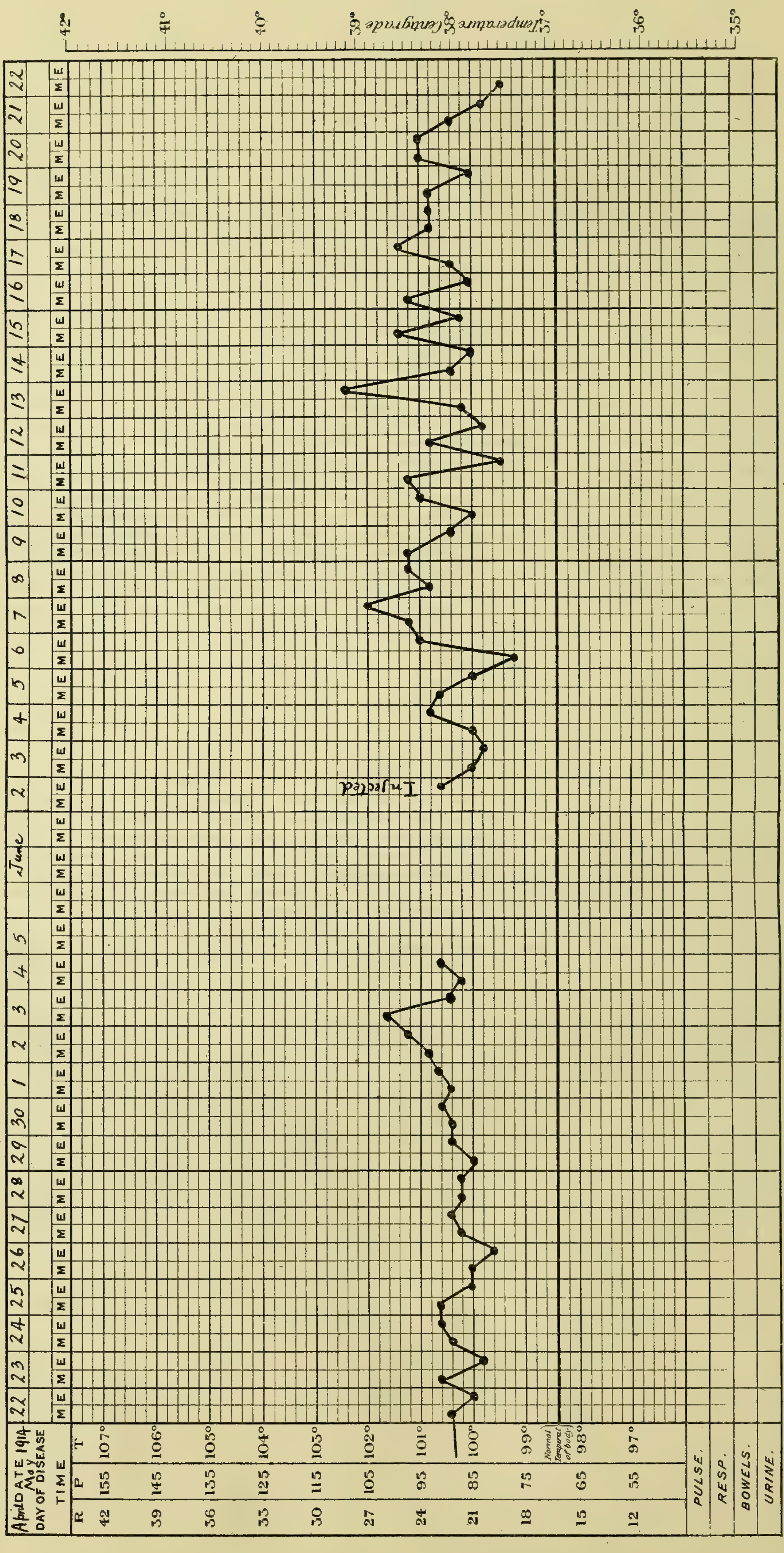

Chart 43. G.-p. 478, natural infection; injected with normal blood (Negro).

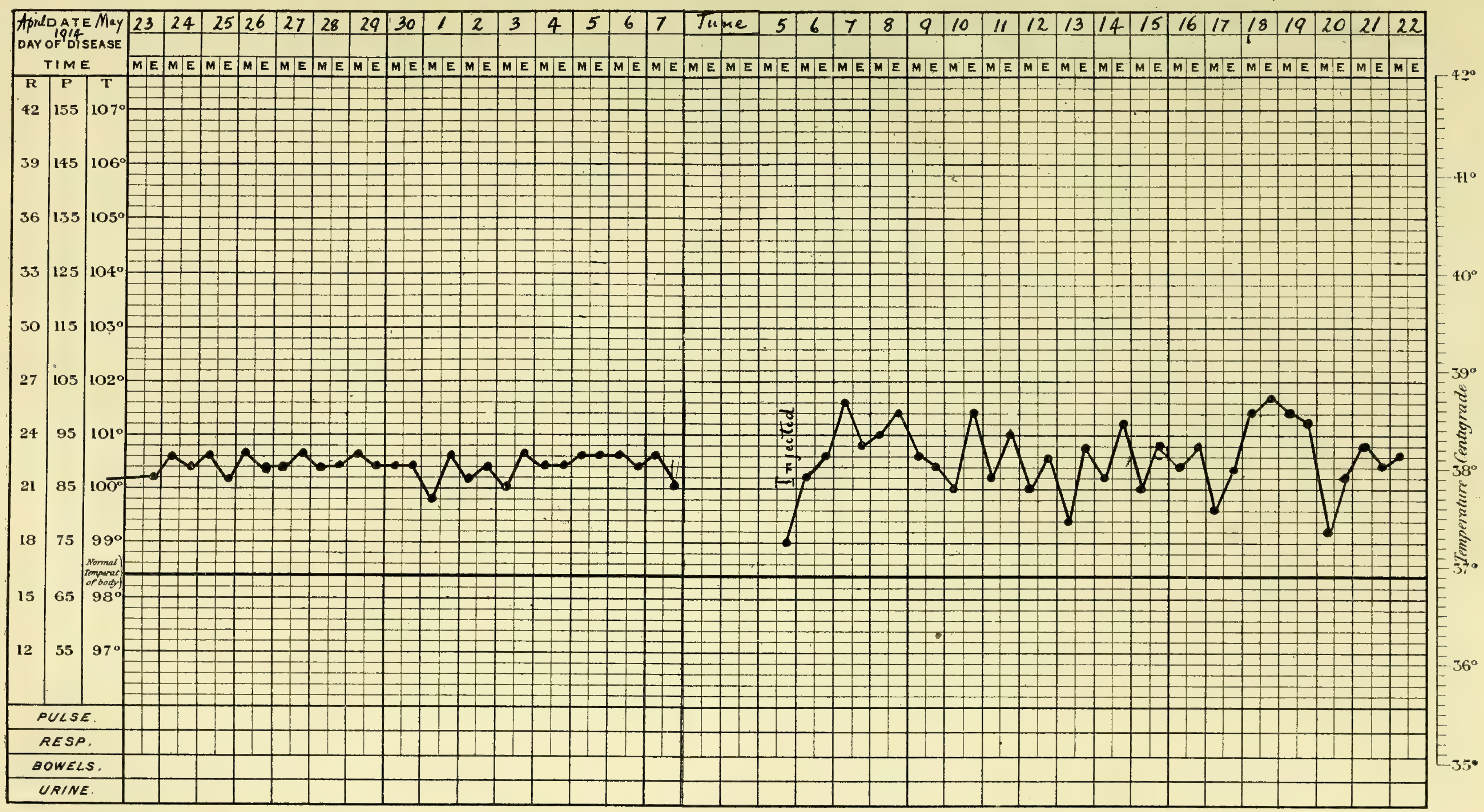

Chart 44. G.-p. 481, natural infection; injected with normal blood (Negro).

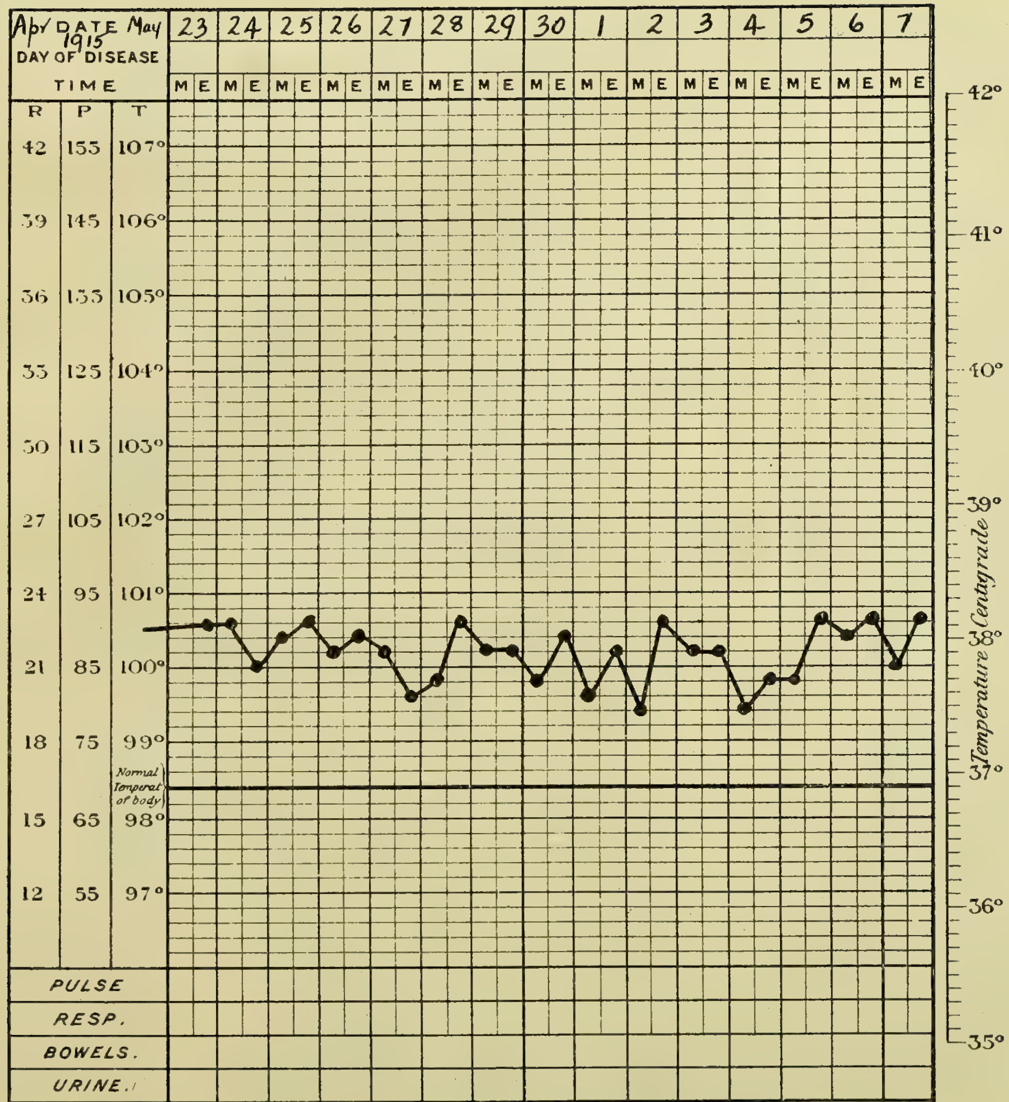

Chart 45. G.-p. 482, natural infection.

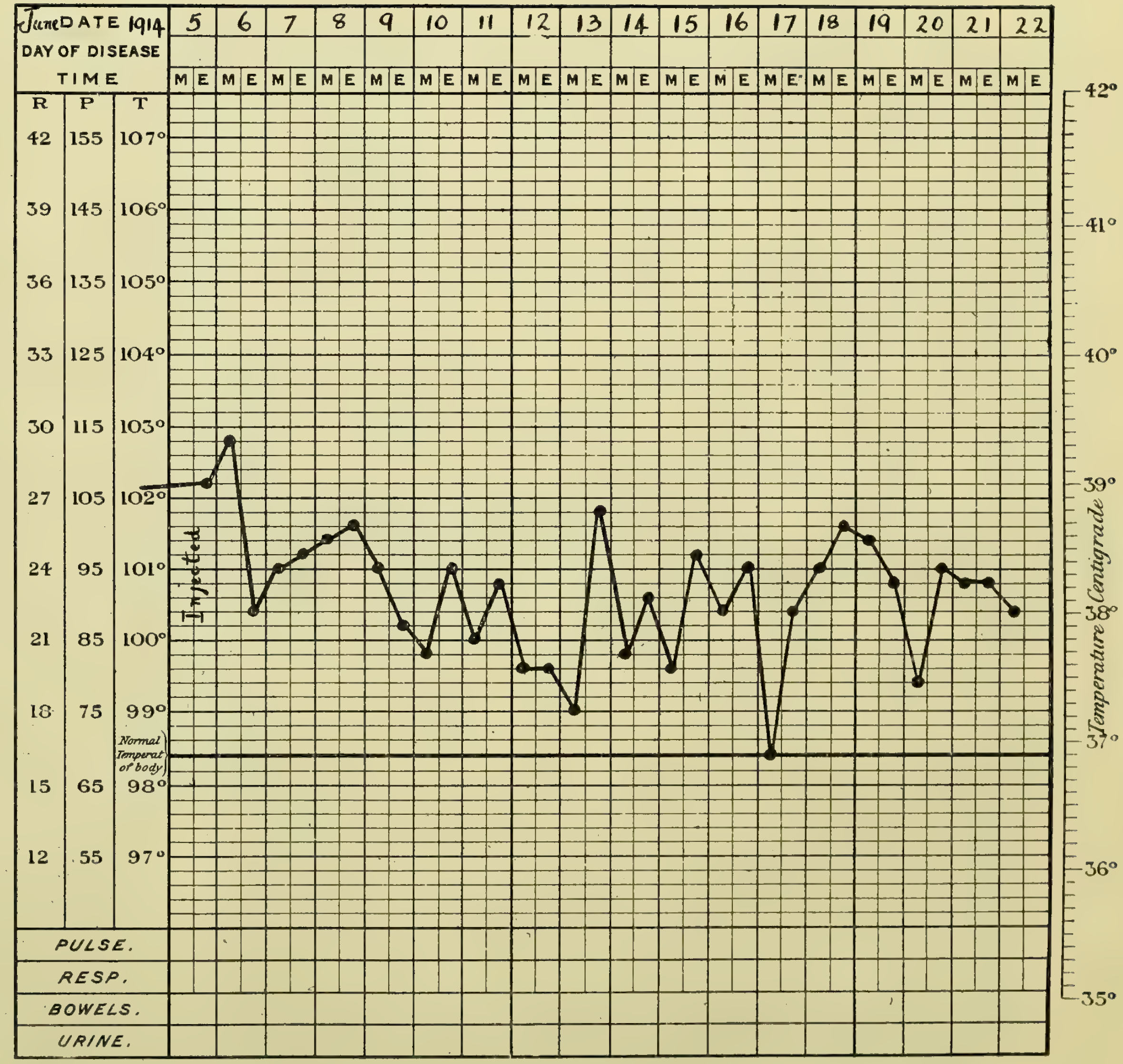

Chart 46. G.-p. 483, clean; injected with normal blood (Negro). Parasites found 6th June, 1914.

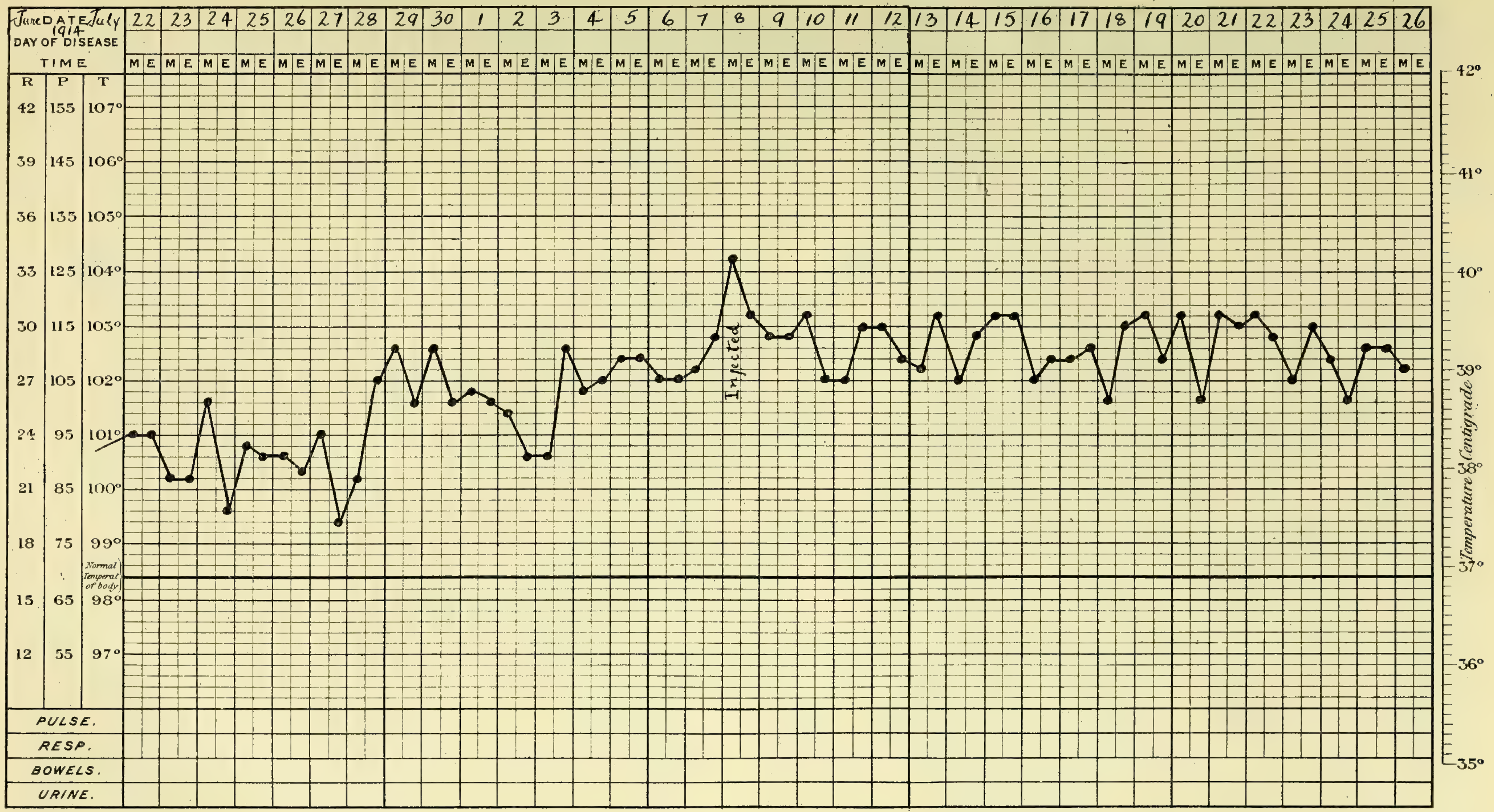

Chart 47. G.-p. 484, natural infection; injected with normal blood (European).

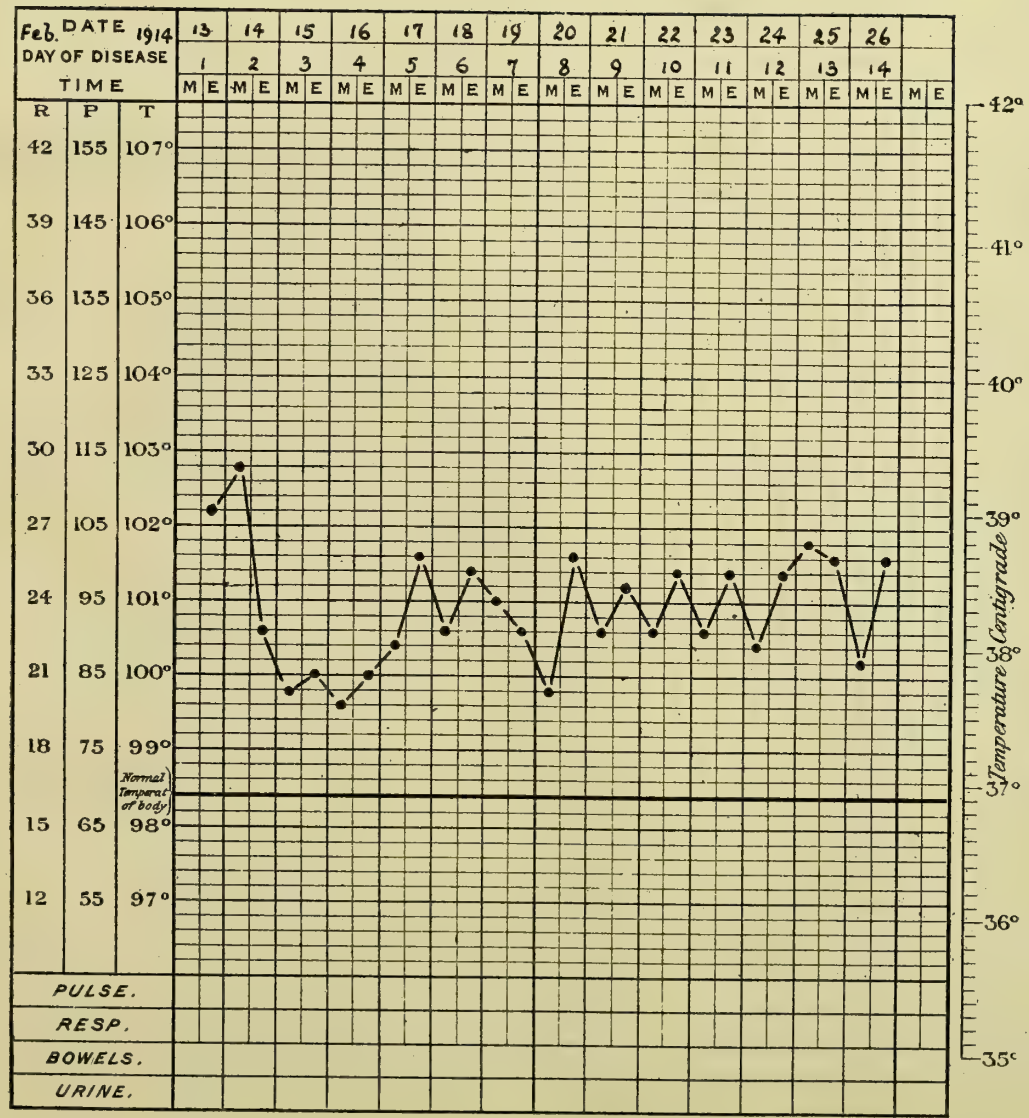

Chart 48. G.-p. 366, clean; injected from yellow fever case L. 121.

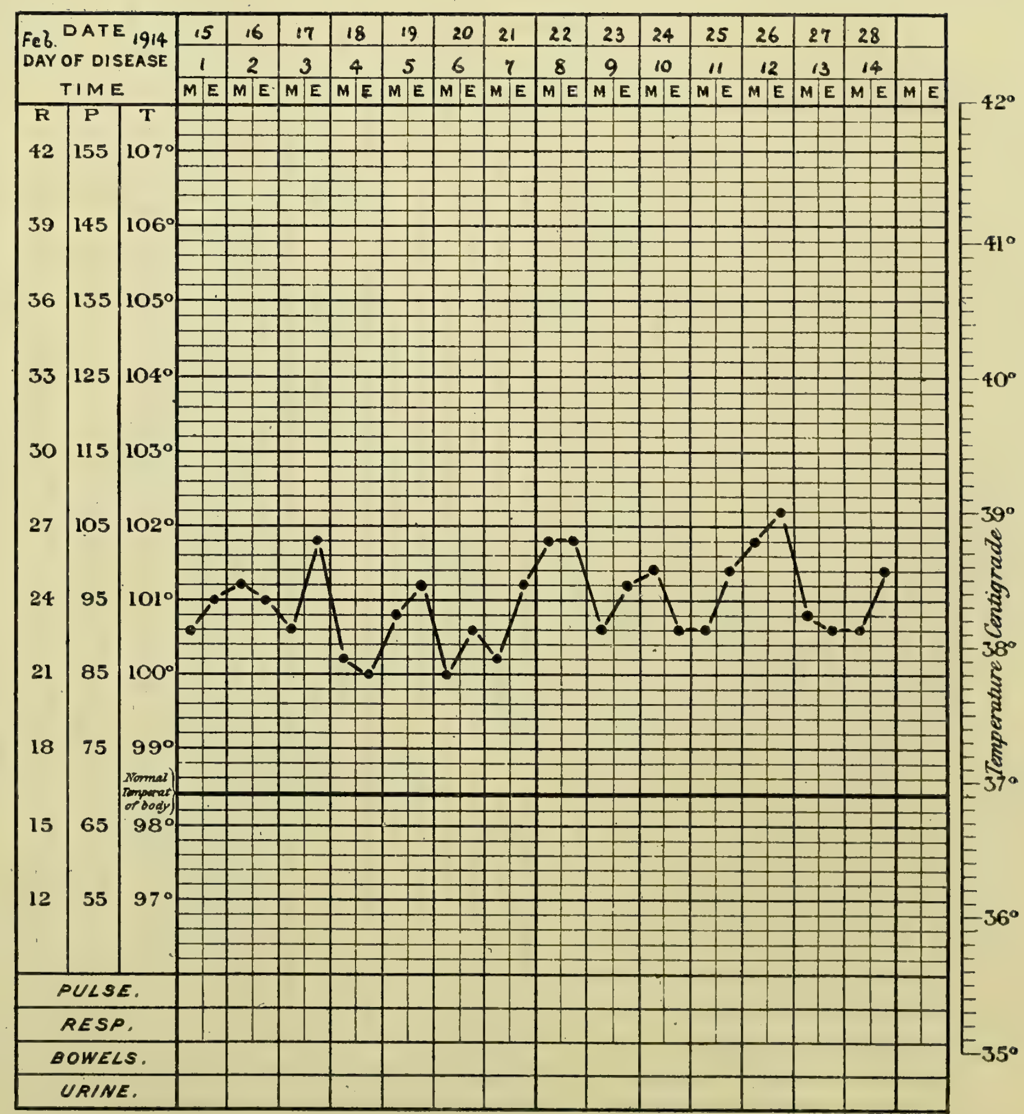

Chart 49. G.-p. 375, clean; injected from yellow fever case L. 122.

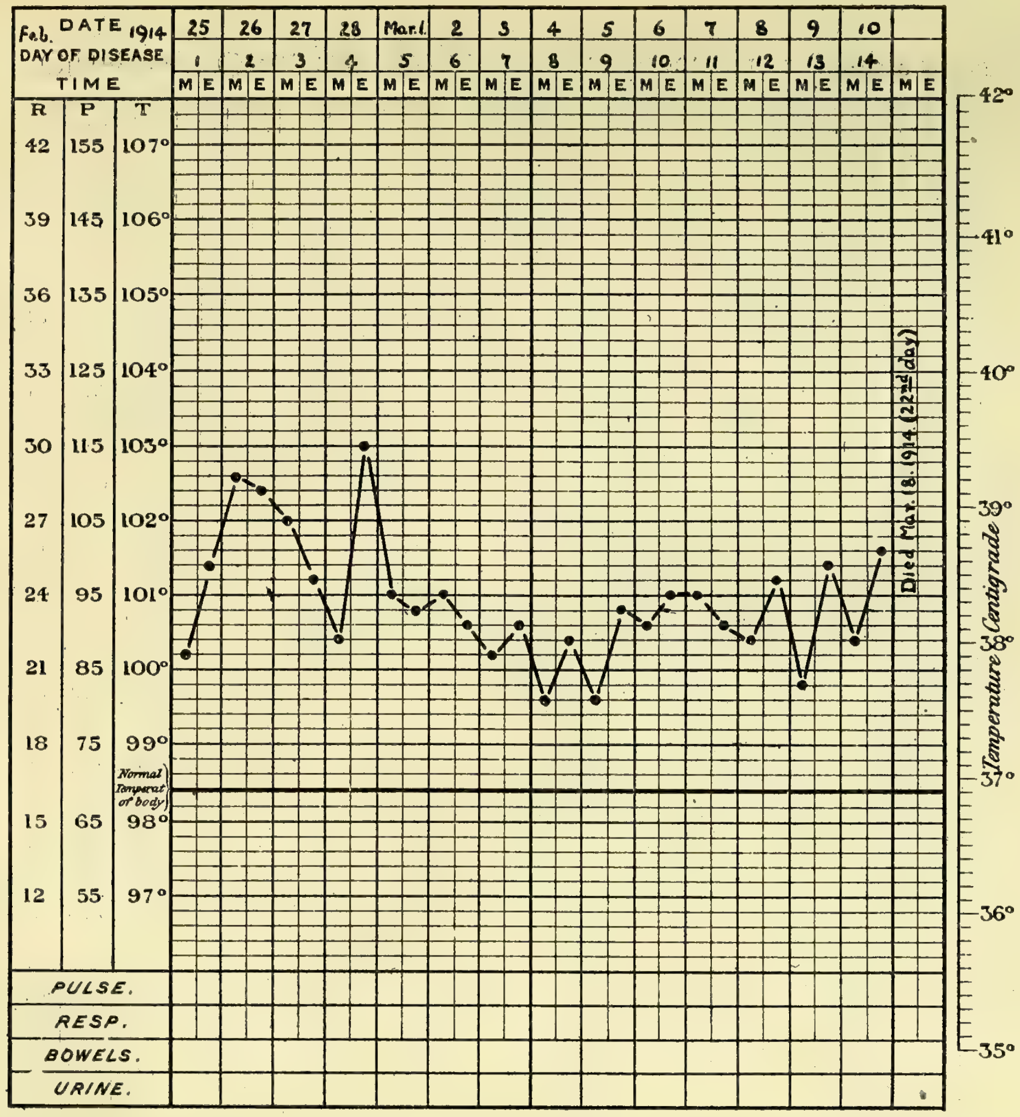

Chart 50. G.-p 380, clean; injected from g.-p. 375, from yellow fever case L. 122.

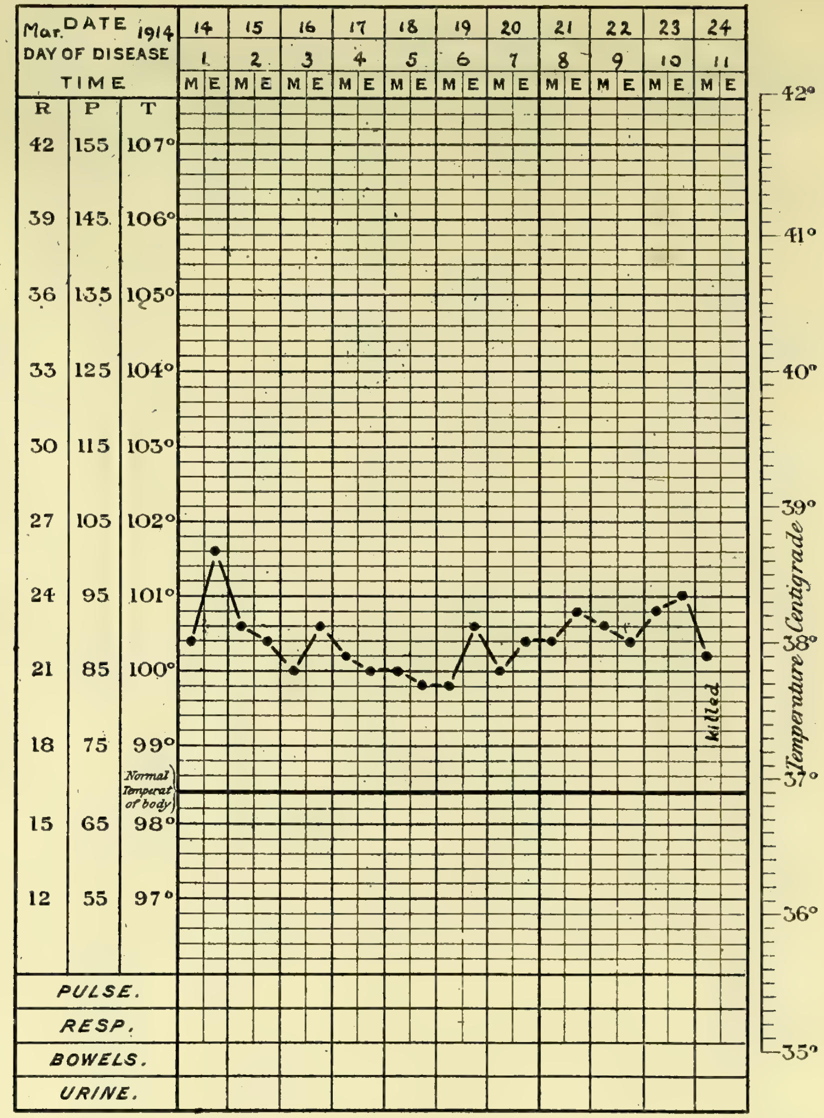

Chart 51. G.-p. 411, clean; injected from g.-p. 400, from g.-p. 380, from g.-p. 375, from yellow fever case L. 122.

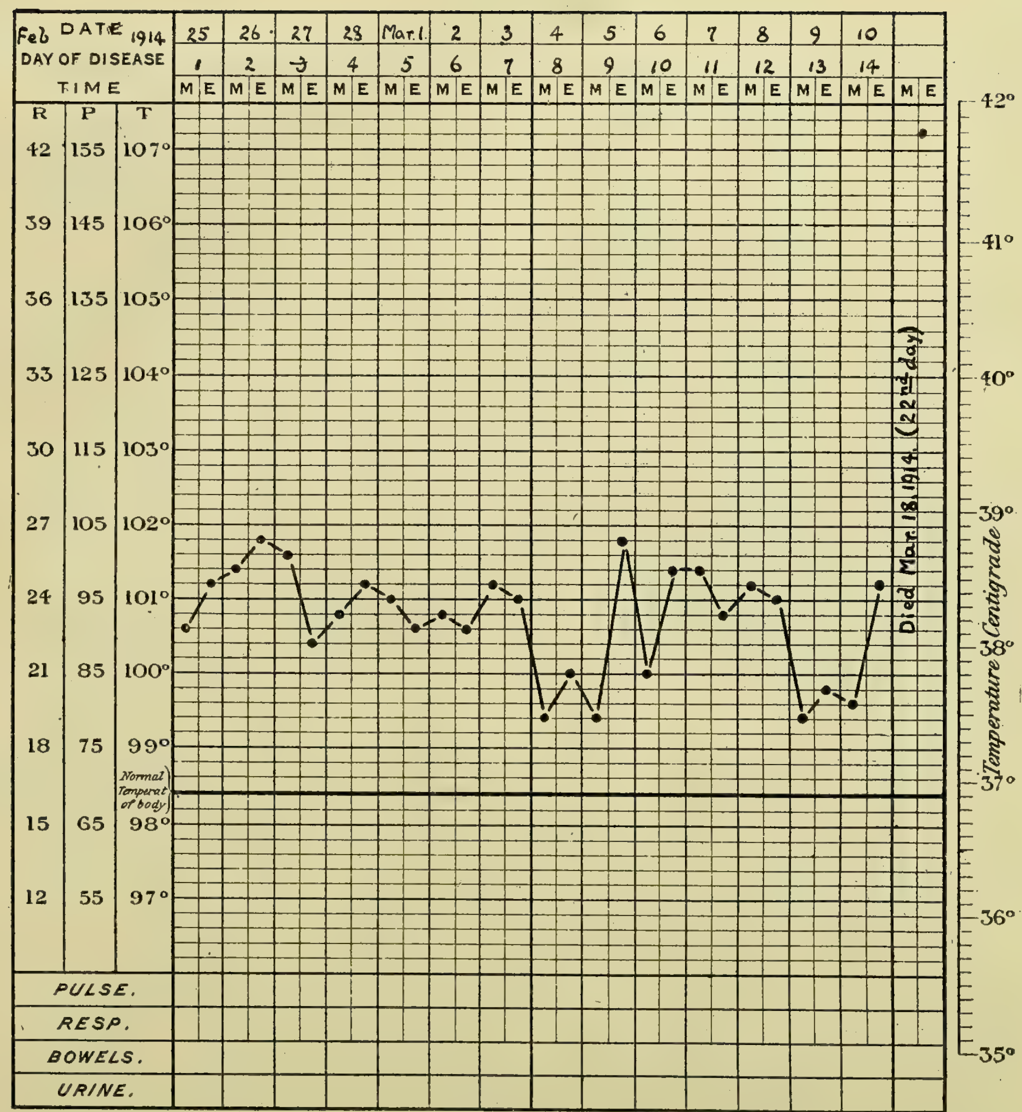

Chart 52. G.-p. 396, clean; 18th sub-inoculation (yellow fever).

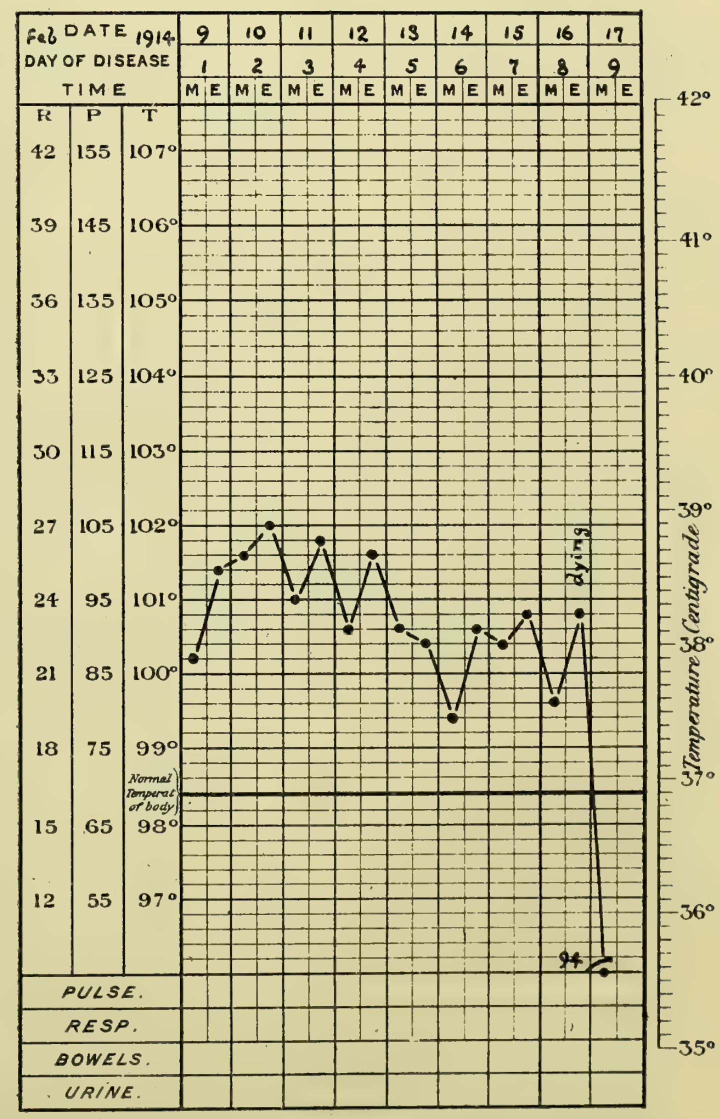

Chart 53. G.-p. 364, clean; 24th sub-inoculation (yellow fever).

REPORTS ON WORK OF YELLOW FEVER INVESTIGATION CARRIED OUT IN THE GOLD COAST COLONY AND THE NORTHERN TERRITORIES OF THE GOLD COAST

BY

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REPORT ON WORK AT SEKONDI, FROM 1 MAY TO 30 SEPTEMBER, 1913

During this time no cases of yellow fever have been found by us in Sekondi.

The total number of sick people examined by us in hospital and outside was 373. Of these, 87 were Europeans, of whom 82 were in hospital and 5 outside, and 286 were natives, of whom 20 were children.

The total number of blood films examined, both thick and thin, was 1,070. Differential counts were made in 729 cases, and total counts in 72, of which 27 were native cases.

Four hundred and seventy-six specimens of urine from 220 patients (83 European and 137 native) were examined, and also the faeces of 63 Europeans and 105 natives.

Blood examinations were made from the following individuals, a differential count being done at the same time:—

European patients		87
Adult native patients		266
		353
Native children		20
		373
Healthy individuals:—		
Europeans	49	
School children (native)	52	
Native prisoners	132	
		233
Total		606 individuals.

Of the urines examined (220 altogether), 25 (15 Europeans and 10 natives) were found to contain albumen. Two Europeans and one native had blackwater fever, and methaemoglobin and granular casts were found in the urine. One European and the native case proved fatal.

Sugar was found in one specimen of urine, that of a European.

The faeces of 86 individuals were found, on examination, to show evidence of infection with helminths. Of these, two were Europeans, one suffering from anaemia and debility, the other from malaria; in both cases the faeces contained ankylostome ova. The following list shows the different helminth ova and embryos in the faeces of 84 natives and the number of cases in which they were found:—

Ascaris	15
Trichiuris	14
Ankylostomes	17
Strongyloides stercoralis	7
Ascaris and ankylostomes	10
Ascaris, *Trichiuris* and ankylostomes	7
Taenia saginata (proglottides obtained)	1
Dipylidium caninum (proglottides obtained)	1
Ankylostomes and *Trichiuris*	7
Ascaris and *Strongyloides stercoralis*	3
Trichiuris, ankylostomes and *Taenia*	3
Taenia, *Strongyloides* and ankylostomes	1

The total numbers of infections with each parasite were:—

Ascaris	35
Trichiuris	29
Ankylostomes	43
Strongyloides	11
Taenia saginata	3

No worms were obtained from the cases in whose faeces ankylostome ova were found. It is therefore not known whether the parasites were of the genus *Necator* or *Ankylostoma*. The faeces of 20 individuals contained amoebae as follows:—

	Entamoeba tetragena	*Entamoeba coli* (cysts)
European	2	3
Natives	3	12

The faeces of three natives were found to contain *Trichomonas intestinalis*.

Of 606 individuals whose blood was examined, malaria parasites were found in 259, as follows:—

Europeans	64
Natives	195

There were nine cases with pigmented leucocytes only, two being Europeans and seven natives.

Of the 64 Europeans:—

51 were diagnosed as suffering from malarial fever.
5 of these remained in their homes, all uncomplicated malaria.

Of the remaining 46:—

33 were uncomplicated malaria. (One had ankylostome ova in faeces.)
7 were malaria with albuminuria and jaundice.
3 were malaria and jaundice, no albuminuria.
3 were malaria and blackwater fever.

Of the 195 natives:—

86 were diagnosed as suffering from malarial fever.
84 of these were uncomplicated malaria.
2 were complicated with albuminuria and jaundice.

The following is a list of the number of infections, with the different species of malaria parasites:—

	Benign tertian	Quartan	Subtertian	Benign tertian and Quartan
European	3	10	28	3
Native	19	25	114	10

	Benign tertian and Subtertian	Quartan and Subtertian	All three combined
European	4	9	7
Native	7	13	7

Total	Benign tertian	Quartan	Subtertian
European	17	29	48
Native	43	55	141
	60	84	189

Sporulating bodies and gametocytes were very rarely found.

Sporulating bodies, 1 Quartan, 1 Benign tertian.

Gametocytes, 1 Benign tertian, 2 Quartan, 7 Subtertian, 1 Benign tertian and Quartan together, 1 Quartan and Subtertian together.

Except in five cases, malaria parasites were never found to be numerous when looked for in thin films. In 60 per cent. of the cases they were found only in thick films, after from ten to fifteen minutes had been spent in looking for them in the corresponding thin films. It was often noticed that a high temperature by no means meant a large number of parasites in the peripheral blood and *vice versa*.

Out of 719 natives whose blood was taken in the daytime, 34 were found to harbour filarial embryos, most of which were found in films taken from 132 native prisoners who appeared healthy.

Samples of the blood of 52 apparently healthy school children were taken during the afternoon; none were found to contain filarial embryos.

Embryos of	*F. perstans*	*F. bancrofti*	*F. loa*
Native patients	4	5	2
Native prisoners	18	3	—

	Embryos of *F. bancrofti* and *F. perstans*
Native patients	1
Native prisoners	1

Totals—	*F. perstans*	24
	F. bancrofti	10
	F. loa	2

No Europeans were found to be infected.

The filarial embryos were all found in day blood.

In the five native patients in whom embryos of *F. bancrofti* were found, none showed any lesions that might have been caused by this parasite. In all five the embryos were found both by day and by night, and in one case, where measured quantities of blood were taken, the *F. bancrofti* embryos were just as numerous by day as by night.

The following is a list of the diseases of the 106 European patients observed by us during five months in Sekondi European Hospital:—

52 Malaria (2 with blackwater fever).
1 Albuminuria and jaundice, no malaria.
3 'Febricula.'
1 Adenitis, syphilis, albuminuria.
1 Heat exhaustion, albuminuria.

1 Siriasis and albuminuria.
1 Dysentery (no intestinal helminths or protozoa found).
3 Amoebic dysentery.
2 Diarrhoea (no intestinal helminths or protozoa found).
2 Alcoholism.
1 Glycosuria.
1 Anaemia.
1 Insomnia.
1 Multiple neuritis.
1 Neuralgia.
1 Tubercle and syphilis.
2 Acute rheumatism and synovitis.
1 Debility.
1 Ankylostomiasis.
9 Surgical.

Monthly return of malaria, etc., amongst Europeans:—

May. 14 in hospital.
6 with malaria.
2 out-patients, both malaria.
Total malaria 8.

June. 13 in hospital.
8 malaria.
1 malaria, out-patient.
Total malaria 9.

July. 14 in hospital.
7 malaria.
Total malaria 7.

August. 29 in hospital.
20 malaria (including 1 blackwater fever).

September. 12 in hospital.
8 malaria (including 1 blackwater fever).
1 malaria, out-patient.
Total malaria 9.

Adult natives and their diseases observed by us during five months in the hospital:—

87 Malaria (1 with albuminuria).
2 Leprosy.
3 Smallpox.
3 Constipation.
1 Lymphatic leukaemia.
4 Rheumatism (gonorrhoeal).
10 Tuberculosis.
10 Lung complications, pneumonia, etc. (2 cases albuminuria).
2 Taeniasis.
15 Ankylostomiasis.
4 Beri-beri.

1 Ascites and albuminuria.
4 Amoebic dysentery.
2 Filaria medinensis (with malaria and albuminuria).
37 Chest complaints, minor and major.
65 Surgical, minor and major.
21 Syphilis and gonorrhoea (2 cases of the latter with albuminuria).
1 Gastritis (malaria and albuminuria).

Native children and their ailments. (Total 20.)

10 Malaria uncomplicated.
1 Ascites and albuminuria (with malaria parasites).
1 Malaria with jaundice and albuminuria.
8 Lung complaints.

Of these three were admitted to hospital:—

2 Pneumonia with malaria.
1 Ascites, albuminuria and malaria parasites.

For testing urines it was considered advisable to use nitric acid and heat for the detection of albumen, and nitric acid for bile pigment, for the following reasons:—

(1) Simplicity.
(2) Heat and nitric acid detect 1 part of albumen in 50,000 parts of urine.
(3) The same reagent can be used for the detection of bile pigment.

Upon one occasion some serum was sent from Yaba, Lagos, to Accra, and from there forwarded to Sekondi for a Widal's reaction. Dilutions of 1 in 40 and 1 in 60 gave a positive reaction with typhoid bacilli.

The Medical Officer of Health has forwarded all the larvae and pupae found by his Inspectors for classification, which is as follows in the order of greatest frequency:—

Stegomyia fasciata.
Pectinopalpus fuscus.
Culex duttoni.
Pyretophorus costalis.
Culex tigripes.
Culex nigrocostalis.

The following biting flies have been found in Sekondi:—

Glossina palpalis.
Glossina tachinoides.
Glossina fusca.
Chironomus species.
Culicoides species.

Chrysops dimidiata.
Chrysops silacea.
Tabanus species.
Stomoxys species.
Acidomyida species (rare).

Simulium and *Phlebotomus* have not been found.

The blood of various animals has been examined from time to time.

That of the cattle often contained trypanosomes and piroplasmata. The commonest tick on the cattle was *Ambylomma variegatum*.

The blood of sheep and European dogs often contained trypanosomes, apparently of monomorphic type; the dogs died. Rats' blood showed trypanosomes of *lewisi* type. No parasites were found in goats' blood.

The blood of snakes and lizards showed haemogregarines.

In birds and fowls no blood parasites were found by us.

Spleen rate:—

Number of children examined	123	
Average age	10½ years.	
Number with minus = 58		123
Number with plus 1 = 34		
Number with plus 2 = 20		
Number with plus 3 = 11		

Appended are the notes and temperature charts, etc., of 27* cases which have occurred between the 1st May and 30th September, 1913, and have been chosen as of special interest with regard to our investigation work. These are:—

Malaria, jaundice and albuminuria ...	7 European cases	9
Malaria, jaundice and albuminuria ...	2 Native cases	
Malaria, jaundice, no albuminuria ...	3 European cases	
Malaria and albuminuria, no jaundice	2 Native cases	
Blackwater fever	3 European cases	4
Blackwater fever	1 Native case	
Pneumonia and albuminuria	3 Native cases	
Syphilis and fever with albuminuria...	1 European case	
Febricula	3 European cases	
Alcohol, albuminuria and jaundice ...	1 European case	2
Alcohol, albuminuria and jaundice ...	1 Native case	

* Eleven only reproduced (see Appendix), viz., all those classed as 'malaria, jaundice, and albuminuria' (European and native), one 'febricula,' and one 'alcohol, albuminuria and jaundice' (European).

In the above, the treatment as shown has been carried out by the Senior Medical Officer or the Medical Officer in charge of the Hospital.

Jaundice has been found difficult to diagnose in the adult native with absolute certainty, unless in very pronounced cases. This is due to the natural coloration of the sclerae and conjunctivae, which even in health are yellow in the greater proportion of natives. In the children, up to the age of fifteen or so, this is different, as the sclerae and conjunctivae in these cases are wonderfully clear.

No data could be drawn from the situation of the dwellings occupied by the above cases and those occupied by the patients diagnosed as suffering from yellow fever on previous occasions.

EUROPEAN HOSPITAL, SEKONDI.

Meteorological Report.—Averages for the months of May, June, July, August and September, 1913.

Month	Thermometers				Hygrometers				Dew point	Relative humidity	Monthly average of extreme daily range	Rainfall		Remarks
	Solar max.	Terres. min.	Shade max.	Shade min.	Dry bulb		Wet bulb					Total for month	Daily average	
					9 a.m.	5 p.m.	9 a.m.	5 p.m.						
May 1st to 31st ...	143·55	72·64	90·07	72·93	82·51	84·19	73·09	74·03	66·94	58·48	16·60	4·73	0·15	
June 1st to 30th ...	143·90	73·06	90·66	72·36	82·63	84·06	73·43	73·56	67·11	58·00	18·30	8·93	0·29	
July 1st to 31st ...	141·83	73·35	87·22	71·41	81·38	81·87	71·96	71·93	65·36	58·12	15·80	8·13	0·26	*Observations taken for 23 days only.
August 1st to 31st ...	140·93	72·00	84·09	71·25	80·29	79·96	68·70	70·09	64·62	59·00	12·74	1·32	0·04	
September 1st to 30th	145·13	73·03	85·33	71·40	81·63	80·93	71·06	70·60	*63·30	*55·00	14·00	2·02	0·06	

SEKONDI.—Post-mortem examinations for the months of May, June, July, August and September.

No.	Cause of death	Date	Remarks
1	Hyperpyrexia from Siriasis	9th May, 1913	European, died in hospital
2	Empyema	29th May, 1913	Spleen smear, malaria
3	Septic meningitis	6th June, 1913	Gram - positive cocci in pus from frontal lobes. Died in hospital
4	Hepatic abscess	6th June, 1913	Spleen smear, malaria
5	Intestinal obstruction	13th June, 1913	
6	Beri-beri	14th June, 1913	Spleen smear, malaria. Died in hospital
7	Endocarditis	21st June, 1913	
8	Endocarditis	22nd June, 1913	
9	General debility	23rd June, 1913	Spleen smear, malaria
10	Pneumonia	27th June, 1913	Spleen smear, malaria
11	Senile decay	29th June, 1913	
12	Pneumonia	3rd July, 1913	Spleen smear, malaria
13	Lymphatic leukaemia	3rd July, 1913	Died in hospital
14	General peritonitis, following strangulated hernia	14th July, 1913	
15	Beri-beri (dropsical)	22nd July, 1913	Spleen smear, malaria. Died in hospital
16	Phthisis pulmonalis	1st August, 1913	
17	Acute pericarditis	13th August, 1913	Spleen smear, malaria
18	Peritonitis	22nd August, 1913	
19	Blackwater fever	September, 1913	Died in hospital
20	Acute enteritis	September, 1913	No protozoal organisms in faeces
21	Fractured neck	September, 1913	Spleen smear, malaria
22	Child, acute malaria	September, 1913	Brain, spleen, liver, subtertian rings numerous

With the exception of six cases (noted above) all the others were brought in dead. In no one of the above cases were any signs suggestive of yellow fever noted.

CASE I

European, aged 37. Malaria (vomiting, jaundice and albuminuria).

1st May, 1913.—Admitted to hospital under the care of the Senior Medical Officer. Three days ago the patient had fever in the evening with a temperature of 102°; he took phenacetin, and the following morning his temperature was 98·4°. On the morning he was admitted to hospital his temperature was 101·6°, and he had been vomiting some greenish material. There were no flecks of blood in the vomited matter. The patient has been six years on the West Coast, and says that he has been in hospital twelve times with bilious fever, the attacks of which begin with shivering, followed by fever and bilious vomiting.

Condition on admission.—Slight headache, no photophobia, but slight nausea. Conjunctivae pale and sclerae show a yellow tinge. Tongue, moist, flabby, and covered with a heavy white fur. Gums pale, pharynx normal.

Thorax.—Nothing abnormal found.

Abdomen.—Liver palpable, $1\frac{1}{2}$ in. below the costal margin, dullness on percussion, commences at the fifth rib, in the nipple line. There is slight epigastric tenderness. Spleen palpable, no tenderness.

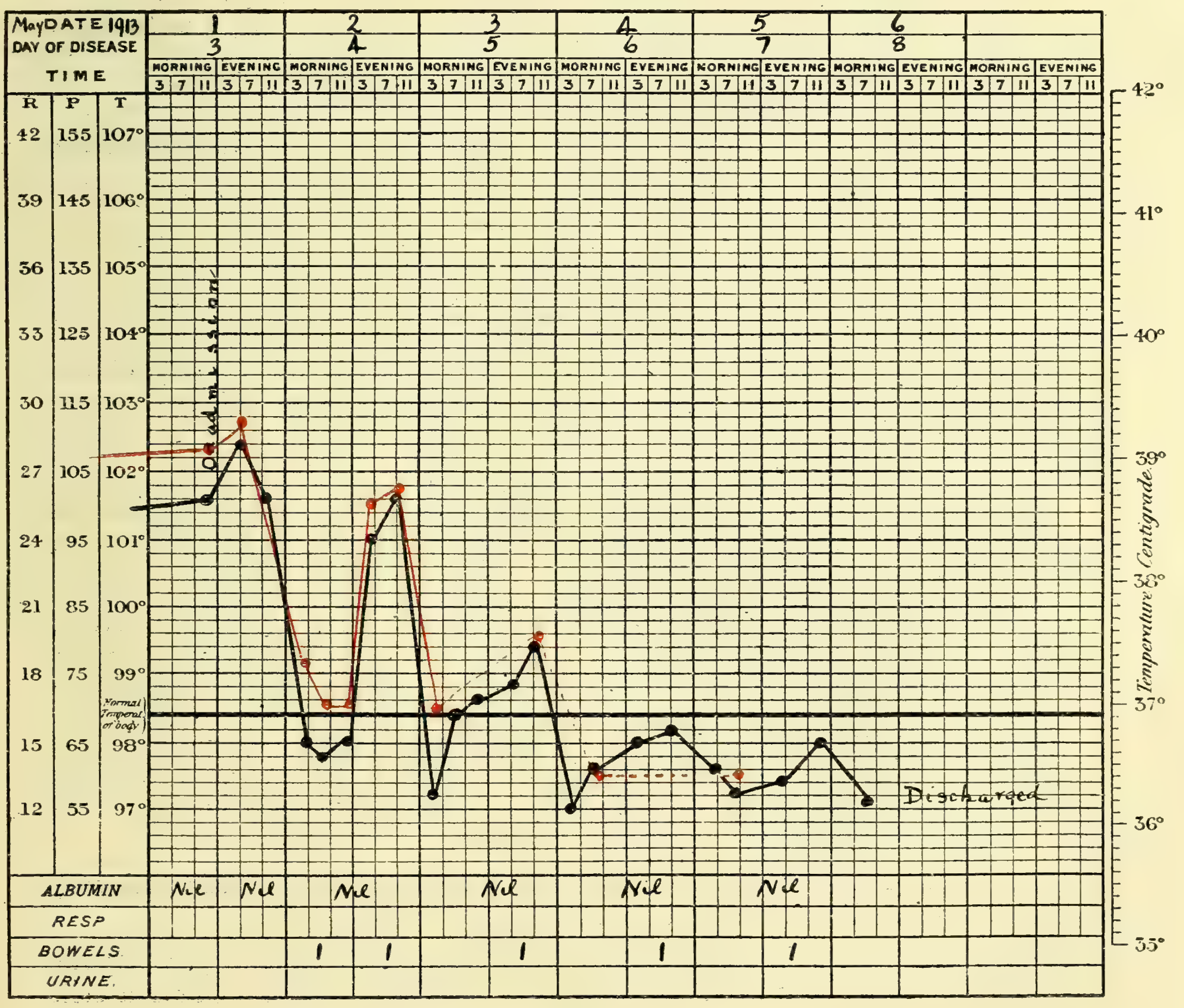


Chart I

Urine.—Bile markedly present, albumen also present in small quantity. A centrifugalised specimen of urine was examined and neither casts nor ova were found.

Blood.—A thin film, taken when the patient's temperature was 101·6°, and stained with Wright's stain, was examined and two subtertian rings were found after a prolonged search. Some red cells showed polychromasia and basophilia.

Differential count (300 cells counted).

Polymorphonuclears...	59 per cent.
Lymphocytes	20 per cent.
Large mononuclears	19 per cent.
Eosinophils	2 per cent.
Total leucocyte count	4,200

Treatment.—Mist. quin. aperiens 1 ounce, in the morning; quinine, 5 grains, four-hourly.

3rd May.—Liver palpable, not tender.

Blood.—No parasites found in a thin film.

Urine.—Trace of bile, no albumen.

Faeces.—Nothing abnormal found.

5th May.—The patient has made uninterupted progress. The sclerae are now white.

Urine.—Trace of bile, but no albumen.

6th May.—The patient was discharged to-day. Throughout the illness, the pulse rate rose and fell with the temperature.

Case 2

European, aged 34. Malaria (vomiting, jaundice and albuminuria).

8th May, 1913.—Admitted to hospital at 6.15 p.m., under the care of the Senior Medical Officer. On the previous night he was attacked with fever, shivering, slight headache, but no photophobia. He also vomited some greenish matter.

Previous history.—He was admitted to hospital on the 14th of March, on which occasion abundant parasites (tertian) were found; he was discharged on the 25th of March, and declares that since then he has taken five grains of quinine daily.

9th May.—No headache, no photophobia, but slight nausea. The conjunctivae are pale and the sclerae show a slight lemon tinge. The tongue is flabby, moist and covered with yellowish fur. The gums are pale, and the pharynx normal.

Thorax.—Nothing abnormal found.

Abdomen.—Slight epigastric tenderness. The liver is just palpable, but not tender. Dullness on percussion begins at the sixth rib in the nipple line. The spleen is palpable.

Urine.—Bile, markedly present and a trace of albumen, but no casts nor ova, even in a centrifugalised specimen.

Blood.—A thin film, taken when the patient's temperature was 99° (Wright's stain), showed only one subtertian ring after a prolonged search. The red cells showed some polychromasia.

Differential count (300 cells counted).

Polymorphonuclears...	60 per cent.
Lymphocytes	22 per cent.
Large mononuclears	18 per cent.
(One pigmented large mononuclear seen.)	
Total leucocyte count	4,300.

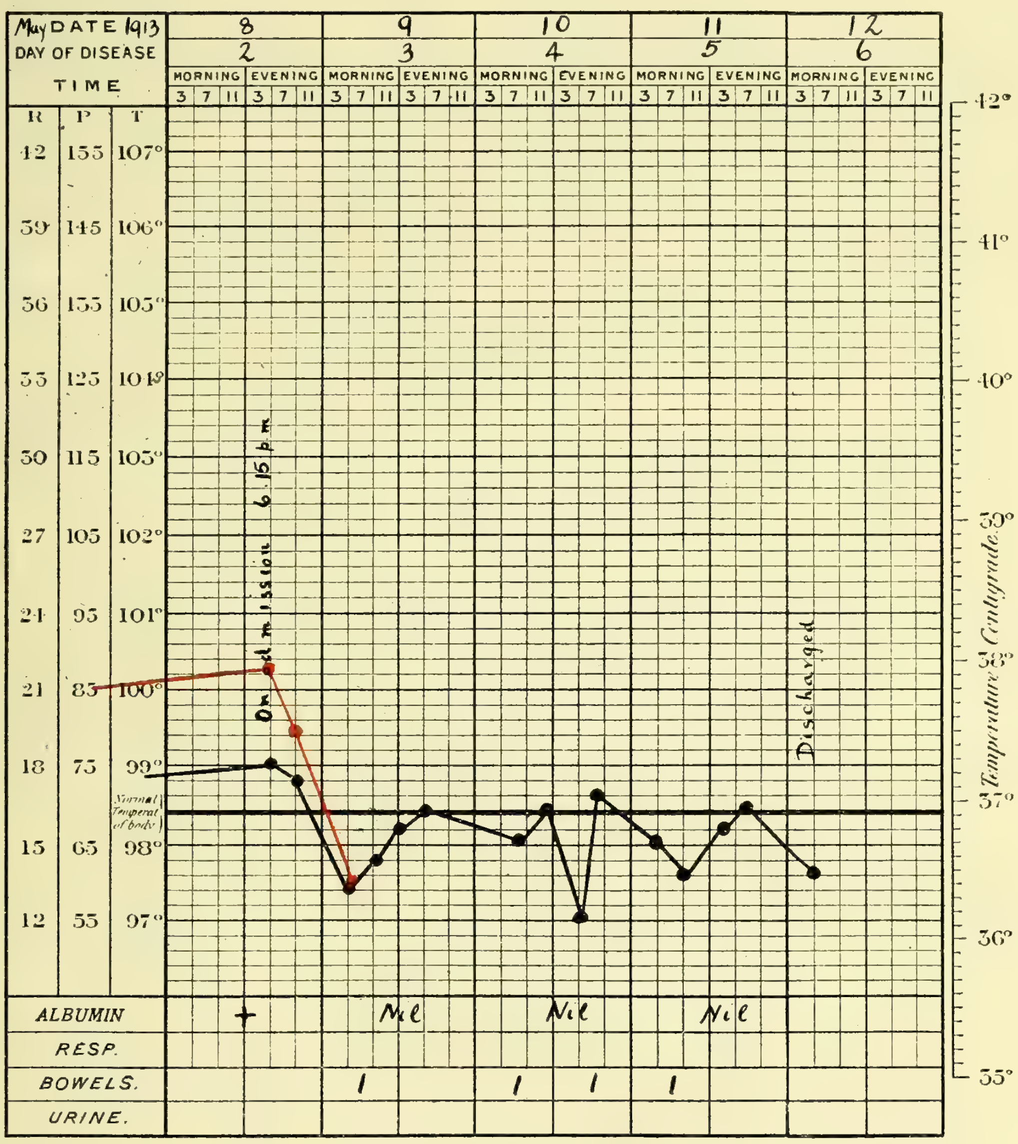


Chart 2

Treatment.—Quinine 5 grains, four hourly. Mist. quin. aperiens in the morning.

10*th May.*—*Urine :* No albumen, but some bile still present.

11*th May.*—*Urine :* No albumen, but a slight quantity of bile.

Faeces.—Nothing abnormal found.

12*th May.*—Liver not palpable, spleen just palpable. Sclerae white. No malaria parasites found in blood (thin film).

Patient discharged.

Case 3

European, aged 29. Malaria (vomiting, jaundice and albuminuria).

16th May, 1913.—Admitted to hospital at 8.0 a.m., under the care of the Senior Medical Officer. Two days previously he had had fever, with a temperature of 104°. He was treated, with quinine, in his own bungalow. Examination of the blood showed the presence of numerous subtertian and benign tertian malaria parasites (ring forms). The fever abated, but on the day before admission it again rose, to 102·2°, and the patient twice vomited some greenish matter. He also suffered from severe frontal headache, but did not complain of photophobia.

Condition on admission.—Conjunctivae injected, marked lemon tinge of sclerae. Tongue flabby with moist yellow fur all over it. Gums and pharynx injected.

Thorax.—Nothing abnormal found.

Abdomen.—Liver palpable, 1 inch below the costal margin, not tender. Liver dullness begins at the sixth rib in the nipple line. Epigastric tenderness is rather marked. Spleen, palpable.

Urine.—A trace of albumen present. A specimen that had been centrifugalised showed neither casts nor ova. Bile, markedly present.

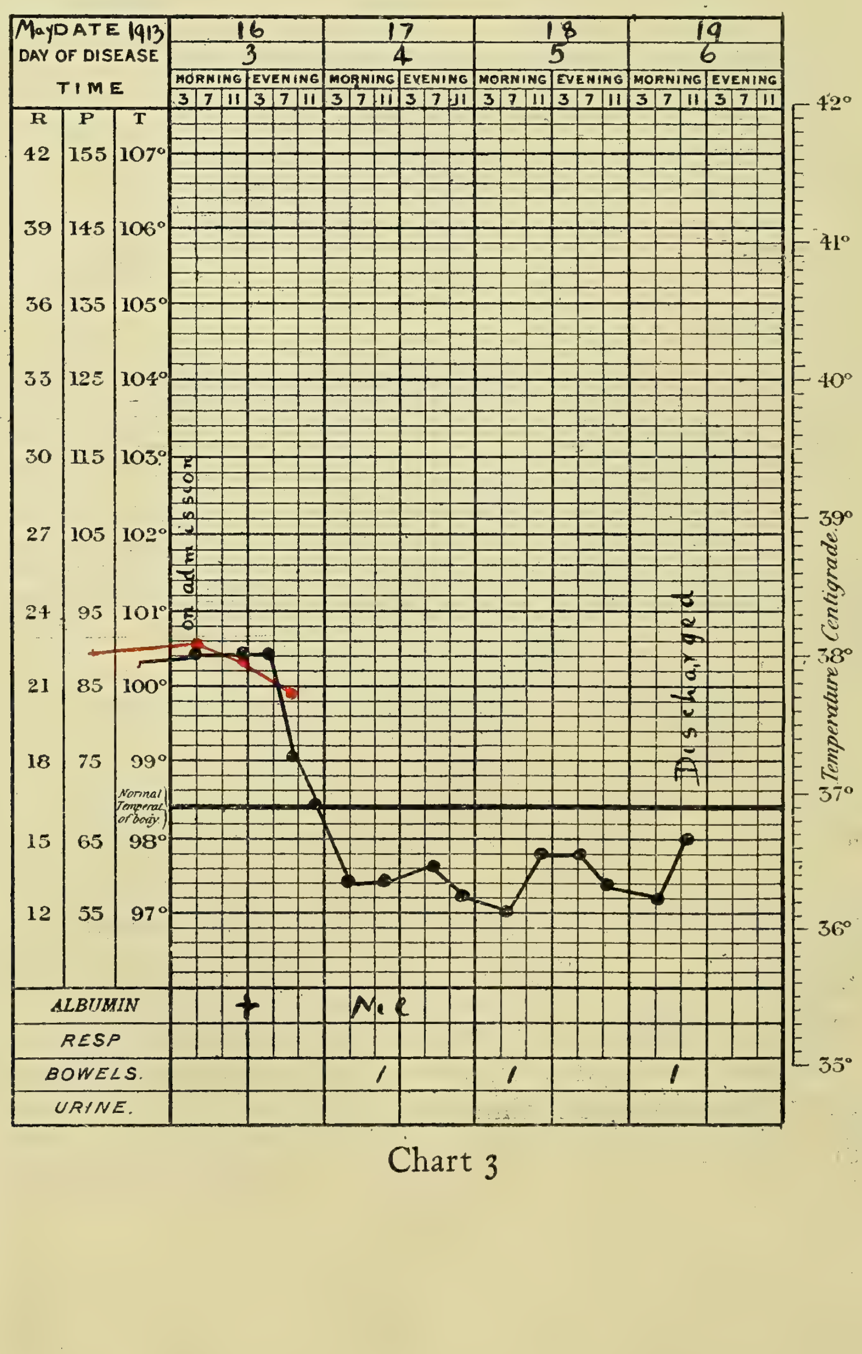


Chart 3

Blood.—Thin film, taken when the temperature was 100·6°, (Giemsa stain) showed scanty subtertian parasites (ring forms), easily found. The red cells show much polychromasia and basophilia. No benign tertian parasites were found.

Differential count (300 counted).

Polymorphonuclears...	44 per cent.
Lymphocytes	19 per cent.
Large mononuclears	35 per cent.
Eosinophils	2 per cent.
Total leucocyte count	3,500.

Treatment.—The patient was put on quinine 5 grains, four-hourly, and mist. quin. aperiens in the morning.

17th May.—Patient has no headache, no injection of eyes, gums, and pharynx, and no yellowness of sclerae. There is no longer any epigastric tenderness.

Urine.—Bile present, but no albumen.

Blood.—No parasites found in thin film.

Faeces.—Nothing abnormal found.

19th May.—Liver not palpable, spleen just palpable.

Urine.—Trace of bile, but no albumen.

Blood.—No parasites found in a thin film.

Patient discharged to-day.

Case 4

European, aged 26, Government official. Multiple neuritis and malaria (jaundice and albuminuria).

1st June, 1913.—Admitted to hospital in the morning, under the care of the Senior Medical Officer.

History.—The patient has already completed four months of his fifth tour of residence on the coast. This is the first time he has been ill during his present tour. He takes five grains of quinine daily. For the past week he has been off duty complaining of biliousness and defective eyesight. His temperature on admission to the hospital was 96·8°, rising in two hours to 98·4°. There has been no fever nor sweating. The pulse is 120 and very weak, the respirations are 18 per minute.

Blood.—Differential count (300 cells counted).

Polymorphonuclears...	54 per cent.
Lymphocytes	25 per cent.
Mononuclears	18 per cent.
Eosinophils	3 per cent.
Total leucocyte count	5,210.

(This blood was taken at about 11.0 a.m.)

Treatment.—Low diet, Sauerbrunnen, brandy, and Perrier water.

2nd June.—On examination, the patient is seen to be lying in a state of comatose stupidity. He is very confused in his statements and expectorates freely on to the bed clothes, without any regard to the close proximity of the examiner. Sometimes vomits after a meal. The face is flushed and he has a dull expression, the skin is hot and moist. The sclerae are yellow, photophobia is well marked and the pupils react very slowly to light and accommodation. The tongue is swollen and there is a white fur at the edges ; the centre is yellow. The teeth are not good, the gums are pale and the pharynx is slightly congested.

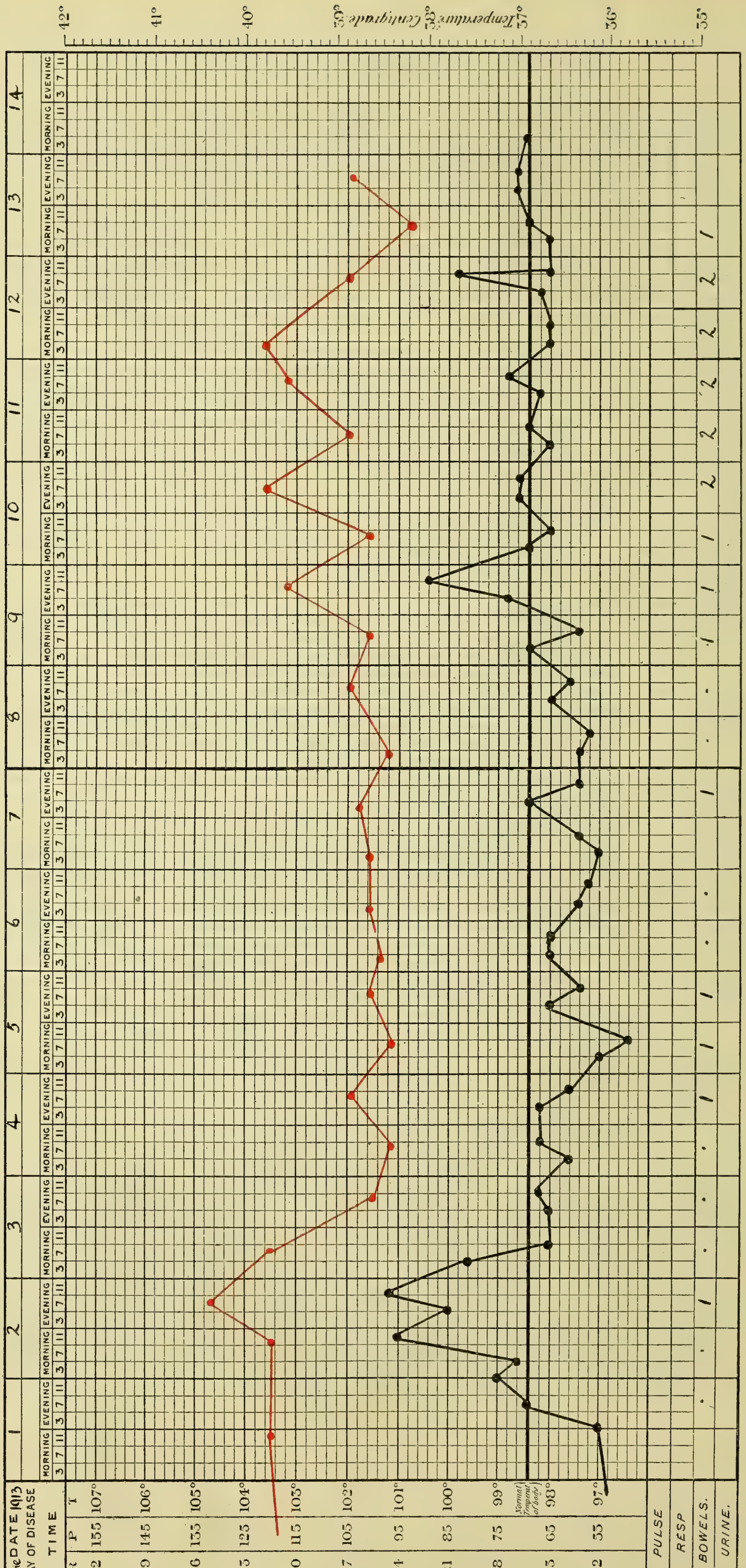

Temperature Centigrade
42° 41° 40° 39° 38° 37° 36° 35°
June DATE 1913
DAY OF DISEASE
TIME
MORNING EVENING
R P T
42 155 107°
39 145 106°
36 135 105°
33 125 104°
30 115 103°
27 105 102°
24 95 101°
21 85 100°
18 75 99°
Normal Temperat of body
15 65 98°
12 55 97°
PULSE
RESP
BOWELS.
URINE.

Chart 4

Liver.—Not palpable, and there is no tenderness; it appears to be somewhat contracted, reaching above to the sixth rib in the mammary line, and below to a little more than one finger's breadth above the costal cartilages. There is no epigastric pain nor tenderness.

Heart.—This appears to be normal.

Lungs.—A few scattered crepitations are heard, otherwise nothing abnormal.

Nervous System.—The knee-jerks are absent and the plantar reflexes are weak. Sensibility to heat and cold are diminished; there is also some loss of sensation. No pain on pressure over the legs. Co-ordination is impaired, especially in the case of the arms. The gait is weak.

Urine.—There is a slight trace of albumen and bile.

Faeces.—Nothing abnormal found.

Blood.—Benign tertian and quartan parasites found in fairly large numbers in thin films.

Treatment.—Mist. quin. 1 ounce.

3rd June.—Differential count.

Polymorphonuclears...	61 per cent.
Lymphocytes	29 per cent.
Mononuclears	7 per cent.
Eosinophils	2 per cent.

No parasites found in either thick or thin films.

Urine.—No bile and no albumen.

Treatment.—Middle diet. The following mixture was ordered: ℞ Quin. hydrochlor. 1 dram, Liq. strych. 1 dram, Tr. digitalis 2 drams, Syr. zingib. 1 ounce, Aqua ad 6 ounces: 1 ounce omn. quart. hor. ex aqua.

9th June.—A slight relapse occurred to-day, but no albumen was found. Examination of the blood (thick and thin film) failed to show the presence of parasites.

14th June.—Patient was discharged to-day, only very slightly, if at all, improved; there was a history pointing to alcoholic excess.

The patient was invalided, and his death on the way home was subsequently reported.

Case 5

European, aged 31, trader. Malaria (jaundice, vomiting and albuminuria).

13th June, 1913.—Admitted to hospital under the care of the Senior Medical Officer.

Previous History.—The patient had been in South Africa for thirteen months, where he had an attack of enteritis; in Northern Nigeria for three and a half years, during which he had two severe attacks of fever with much vomiting of dark material; and on the Gold Coast for twelve months, where, at the end of the first two months, he suffered from dysentery, vomiting and fever. For six months past he has taken quinine regularly.

The day before admission patient had an attack of fever with shivering and vomiting. The vomit consisted of yellow and 'black' matter. He took thirty grains of quinine.

Condition on admission.—Severe headache, chiefly frontal, but no photophobia. Sclerae yellowish but not injected. Conjunctivae pale and rather yellow. Gums and pharynx normal. Tongue moist and covered with white fur. Skin showed a slight lemon tinge all over.

Thorax.—Nothing abnormal found.

Abdomen.—No epigastric tenderness. Liver neither palpable, tender, nor enlarged on percussion. Spleen not palpable.

Urine.—Dark amber colour, sp. gr. 1020; bile and a trace of albumen present. On microscopical examination neither casts nor ova were found.

Blood.—Thin film (stained haematoxylin) showed two or three quartan and subtertian malaria parasites (ring forms). It took a long search, however, to find these.

Faeces.—Nothing abnormal found.

On the day of admission, patient vomited once, the vomit consisting of greenish bile; there were, however, no flecks of blood in it. After this he suffered from nausea, but did not vomit any more.

Treatment.—Quinine 5 grains, four-hourly.

14*th June.*—Jaundice, about the same.

Urine.—Bile, but no albumen, present.

Blood.—In a thin film (stained with haematoxylin) two subtertian rings were found after a prolonged search.

Treatment.—An intramuscular injection of quinine, grs. vi, was given. This was repeated at 11 a.m. and 7 p.m. on the 15th, on which date the patient was also given calomel, ½ grain, and mist. alb.

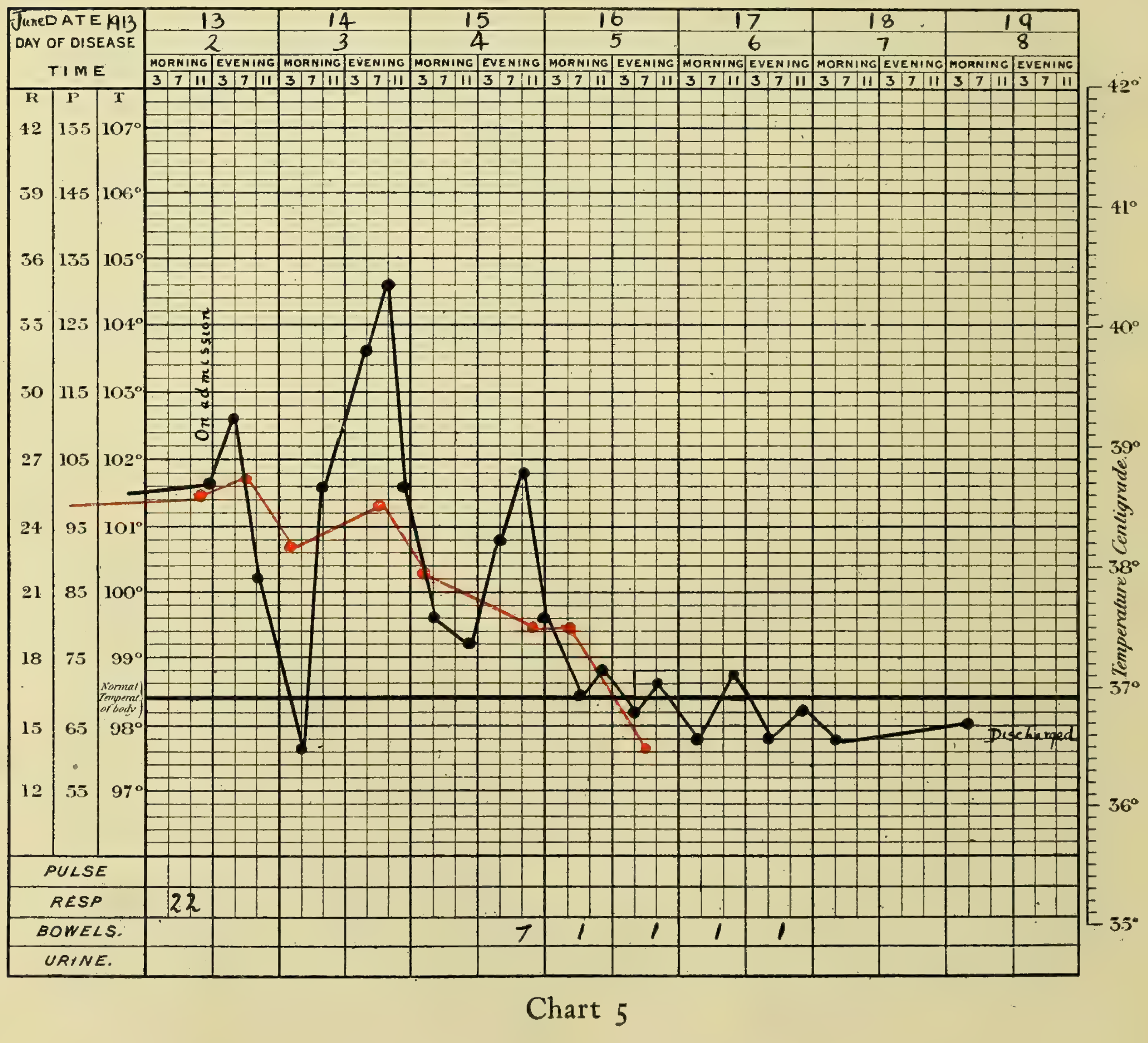


Chart 5

16th June.—Patient convalescent, no jaundice.

Urine.—No albumen, but a trace of bile.

Blood.—In a thin film, stained with haematoxylin, no parasites were found after a careful search.

Treatment.—Mist. quin., half an ounce, four-hourly.

17th June.—Differential count (300 cells counted) :—

Polymorphonuclears...	53 per cent.
Lymphocytes	22 per cent.
Large mononuclears	21 per cent.
Eosinophils ...	4 per cent.
Total leucocyte count	6,100

Urine.—No albumen, but a trace of bile.

19th *June.*—Patient discharged. Throughout the illness the patient's pulse (while under observation) rose and fell with the temperature.

Case 6

European, aged 47, Government official. Malaria (vomiting, jaundice and albuminuria).

23rd June, 1913.—Admitted to hospital under the care of the Senior Medical Officer. Patient has completed five months of his second tour, and has had fair health. He was formerly in British Guiana, to which place he first went in 1889 ; he had an attack of gastric catarrh while there. During his last tour in West Africa he was invalided for hepatitis ; he had also had malaria. Throughout the week before admission, he was ill with frequent vomiting, sometimes of 'dark,' and sometimes of greenish matter ; he also had fever and continuous thirst.

Condition on admission.—Face, pale and slightly yellow, with an anxious expression ; slight headache. Eyes, slight photophobia, conjunctivae and sclerae injected and yellow. Tongue, white fur in the middle, edges and tips clean. Gums and pharynx injected.

Thorax.—Lungs, some emphysema. Heart sounds, faint and regular, no abnormal sounds.

Abdomen.—Slight epigastric tenderness. Liver, not palpable. Spleen, also not palpable.

Skin.—Slight yellow tinge all over.

The patient vomited twice; bile and slight flecks of blood were seen in the vomit.

Urine.—Colour, dark amber, sp. gr. 1014, bile markedly present and also a small quantity of albumen. A specimen that had been centrifugalised showed no casts and no ova under the microscope.

Blood.—Thin film (stained haematoxylin and eosin) showed numerous subtertian malaria parasites (ring form) after quinine had been given. Some polychromasia and basophilia of the red cells was observed.

Differential count (300 cells counted) :—

Polymorphonuclears...	79 per cent.
Lymphocytes	10 per cent.
Large mononuclears	11 per cent.
Total leucocyte count	3,000

Treatment.—Mist. quin. aperiens. An intramuscular injection of quinine, 6 grains, was given at 7.15 p.m.

24th June.—Patient much improved, but there is still some jaundice, and he still has some inclination to vomit.

Urine.—Slight trace of albumen, no casts, bile present, but not so marked.

Blood.—Thin film, no parasites seen. Thick film (stained haematoxylin and eosin) shows subtertian rings, but they are very scanty.

Treatment.—Quinine, 6 grains, was given intramuscularly at 11 a.m. and at 7 p.m.

25th June.—Improvement marked, no jaundice.

Urine.—No albumen, but a trace of bile.

Blood.—Very few parasites seen in thick film.

Faeces.—Nothing abnormal found.

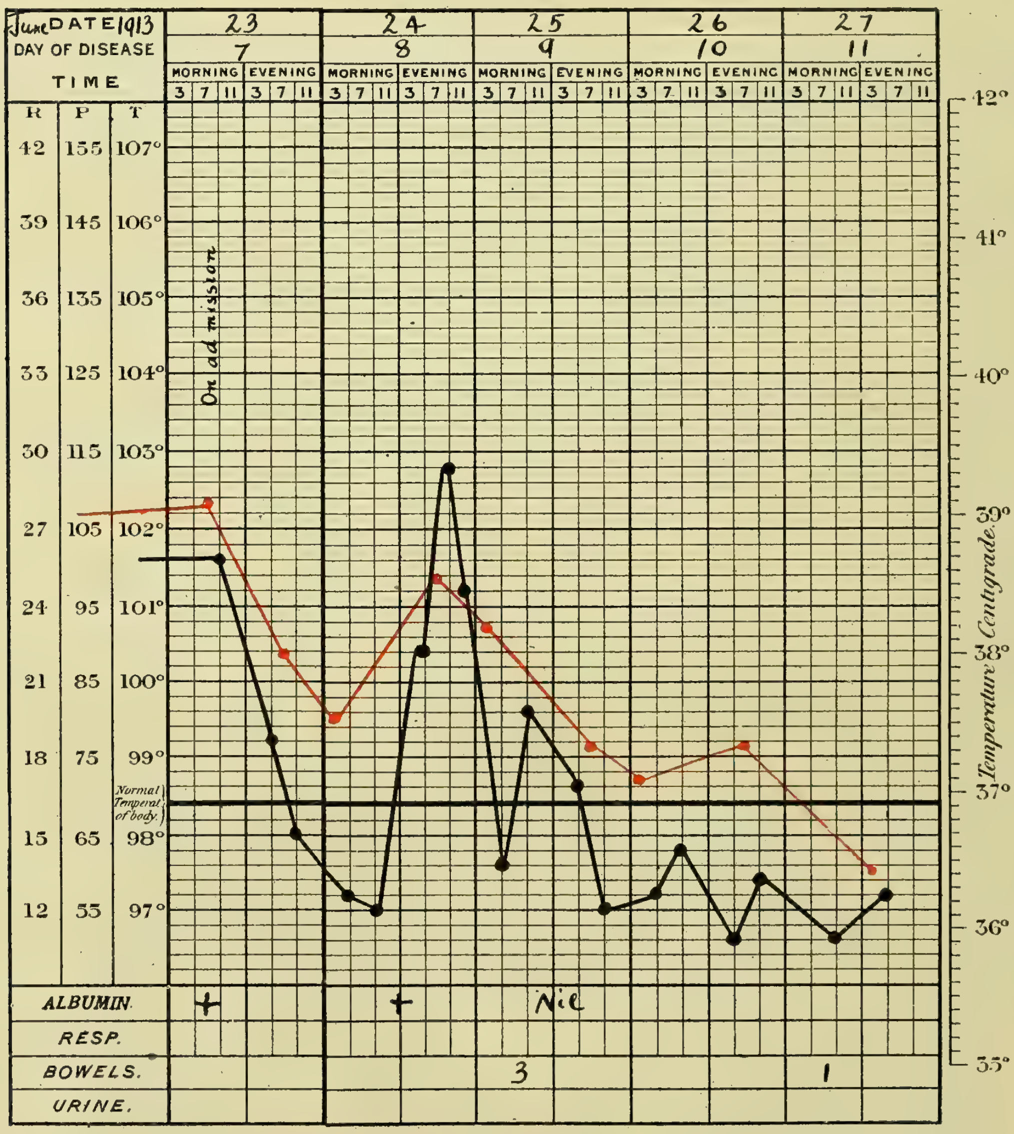
Treatment.—Quinine, 6 grains, was given intramuscularly at 12.30 p.m. and at 8 p.m.

26th June.—Patient ordered quinine, 15 grains daily, by the mouth.

30th June.—Patient pale, but otherwise he feels well.

Blood.—No parasites found in a thick film.

Urine.—No albumen, but slight trace of bile.



Case 6

Differential count (300 cells counted) :—

Polymorphonuclears...	60 per cent.
Lymphocytes	19 per cent.
Large mononuclears	19 per cent.
Eosinophils	2 per cent.
Total leucocyte count	5,400

3rd July.—Since the 27th the patient's temperature has remained normal or subnormal. He was discharged to-day.

Throughout the illness, while under observation, the pulse rate rose and fell with the rise and fall of the temperature.

Case 7

European, aged 37. Malaria (jaundice, albuminuria—C_2H_5OH).

31st July, 1913.—Admitted to hospital, under the care of the Senior Medical Officer, with a bad attack of vomiting following an indiscretion in the matter of food and drink, both as regards quality and quantity, associated with marked urticaria all over the body.

Condition on admission.—Conjunctivae pale, sclerae white. Tongue covered with heavy white fur, breath foul.

Thorax.—Nothing abnormal.

Abdomen.—Liver not palpable; on percussion, found to be somewhat decreased in size. Spleen just palpable.

Urine.—Sp. gr. 1033, no albumen, slight trace of bile.

Blood.—Thin film (stained Giemsa) shows benign tertian malaria parasites, but they are scanty.

Differential count (300 cells counted) :—

Polymorphonuclears...	68 per cent.
Lymphocytes	26 per cent.
Large mononuclears	5 per cent.
Eosinophils	1 per cent.
Total leucocyte count	6,200

Faeces.—Nothing abnormal found.

Treatment.—A hypodermic injection of morphia and atropine was given at 7 p.m. on the day of admission. Since then the patient has been treated with mist. quin. aperiens, calomel, etc. Patient was discharged on the 3rd August, 1913.

16th August, 1913.—Patient was readmitted to hospital. He has been drinking, not wisely but too well. He complains of nausea, but says that he has not been vomiting.

Condition on admission.—Conjunctivae and sclerae injected and red. Slight yellow tinge of skin. Tongue covered with a heavy brownish fur, breath foul, gums pale and pharynx injected.

Abdomen.—Liver not palpable nor enlarged on percussion; some tenderness on deep palpation. Tenderness over epigastrium. Spleen just palpable.

Urine.—Trace of albumen, no casts and no blood. Bile markedly present.

Blood.—Thin film (stained Giemsa) shows polychromasia and basophilia of red cells, but no parasites were found even after a fairly long search.

Differential count (300 cells counted) :—

Polymorphonuclears...	58 per cent.
Lymphocytes	24 per cent.
Large mononuclears	10 per cent.
Eosinophils	8 per cent.
Total leucocyte count	4,500

In thick film (stained Giemsa), scanty, subtertian, benign tertian and quartan malaria parasites were seen.

Faeces.—Nothing abnormal.

Treatment.—An intramuscular injection of quinine, 6 grains, was given at 7 p.m. A purgative was also administered.

17*th August.*—Examination of the urine showed the presence of bile, but no albumen.

Treatment.—Quinine, 6 grains, intramuscularly, at 11 a.m. and 7 p.m.

19*th August.*—Jaundice has now disappeared, and the urine is free from albumen, though there is still a trace of bile present.

Treatment.—The intramuscular injection of quinine was repeated yesterday morning at 11 a.m. To-day the patient was given quinine, 15 grains, by the mouth.

Patient discharged. This patient has been over eleven years in East and West Africa, and believes himself immune to malaria. He only takes quinine when he has 'fever'; had slight fever three months previously.

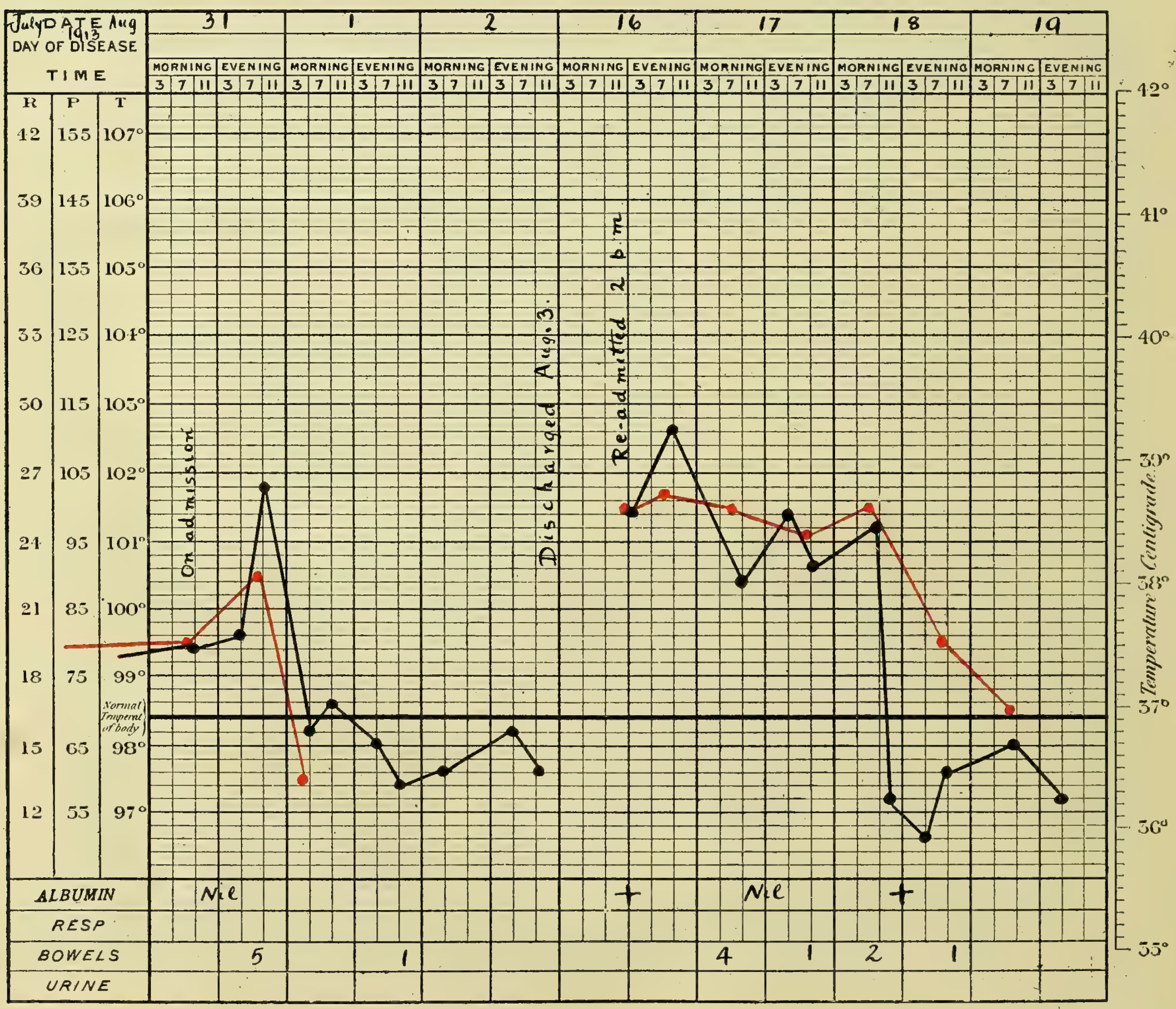


Chart 7

Case 8

Native, aged 30, Government official. Gastritis and malaria (jaundice and albuminuria).

6th August, 1913.—The patient was admitted to hospital in the morning. He said he had had very bad fever, accompanied by vomiting of a bilious character, and sweating. He also complained of headache, but there was no photophobia. The fever began three days ago, before which time his health had been good.

Condition on admission.—Patient was a well-developed man. The skin was hot and moist, there was no rash. The sclerae were yellow and the conjunctivae jaundiced. His teeth were good, the gums were pale and the pharynx normal. The tongue was flabby and covered with moist white fur; the breath was foul. The temperature was 99°, the pulse 72 and the respirations 19. The reflexes were normal.

Thorax.—Lungs and heart sound.

Abdomen.—Liver and spleen not enlarged, no pain nor tenderness. He had an uneasy feeling over the epigastrium with a tendency to vomit bile.

Urine.—Sp. gr. 1028, slight trace of albumen and bile.

Blood.—No parasites were seen in a thin film, but in a thick one, stained Giemsa, benign tertian parasites were found.

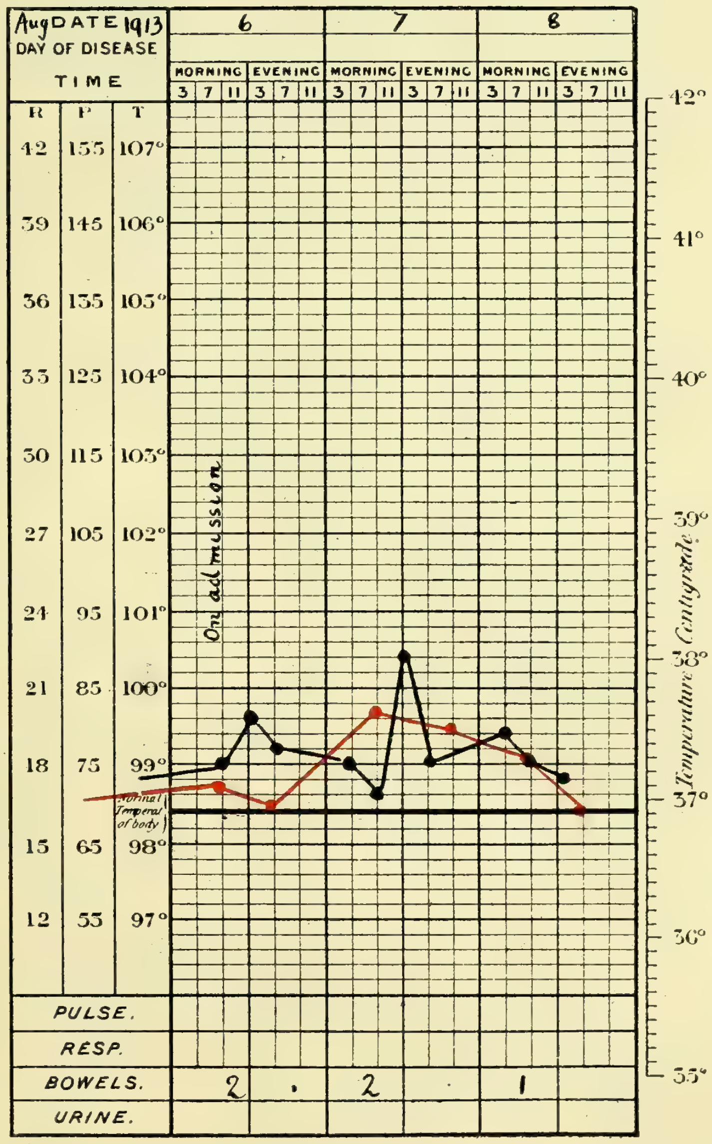


Chart 8

Differential count :—

Polymorphonuclears...	55 per cent.
Lymphocytes	28 per cent.
Large mononuclears	14 per cent.
Eosinophils ...	3 per cent.
Total leucocyte count	4,000.

Faeces.—Nothing abnormal found.

The patient looks as though he were recovering from the effects of alcohol. He was treated as an ordinary case of malaria and discharged cured on the 9th August.

Case 9

On the 3rd of September information was received by the Medical Officer of Health that several natives had died during the past week at a village called Kajebil some 15 miles from Sekondi. Upon our enquiry at the village this was not verified, in fact only one death had occurred, namely an old man a full week previously, the cause of death said to be old age.

There was only one case of sickness in the village. This was a boy, 10 years of age, who had been ill for six days, during which period he had complained of "Fever" sweating at night, vomiting of bile and inability to take his food. When seen on the 5th September, he was weak, complaining of vomiting, headache, photophobia, constipation and inability to eat. No pain or tenderness in any other part of the body. Temperature 98·5, pulse 120 (probably nervousness), respiration 20, skin dry and cool, sclerae, slightly yellow, conjunctivae, jaundiced. Tongue flabby with dirty white fur in the centre, clearing at the tip and edges. Pharynx and gums congested, the latter bleeding slightly on pressure. Teeth good.

Abdomen.—The liver was enlarged about 1½ fingers' breadth below the costal margin in the mammary line, no tenderness. Spleen easily palpable, no very marked tenderness. No pain, though slight uneasiness over epigastrium, vomited pure bile once during examination. (Unable to take food because it set up vomiting.)

Thorax.—Lungs and heart, sound.

Urine.—Dark amber colour, showing a large amount of bile and albumen, but no blood.

Blood.—Thin smears (stained Giemsa) taken at 2 a.m. on the 5th showed everal subtertian rings ; large number seen in thick film.

Differential count :—

Polymorphonuclears...	55 per cent.
Lymphocytes	28 per cent.
Large mononuclears	14 per cent.
Eosinophils ...	3 per cent.
Total leucocyte count	4,600.

The patient was given a dose of calomel, and quinine was administered.

6th September.—Temperature 98°, pulse 100. The patient had had a good night's rest, felt very much better, no headache, vomiting completely stopped ; in fact he was eating heartily when seen.

Urine.—No albumen, but still some bile.

This case recovered, and no further cases have been reported.

Case 10

European, aged 25 years, non-official. Febricula.

13th August, 1913.—Admitted to hospital under the care of the Senior Medical Officer. This is his first tour, he has been out six months and has had no previous illness, takes quinine regularly. He lives at an hotel, and has often been bitten by mosquitoes and "sand flies," the latter being common in the office where he works. He has not been bitten by tsetses. The present illness began suddenly yesterday evening at 6 p.m. with severe frontal headache, slight pains in the small of the back and legs, and lassitude. He had no nausea nor vomiting, but felt feverish. He took 15 grains of quinine and the following morning, after a sleepless night, he took another 15 grains.

Condition on admission.—Complains of headache and 'tiredness' and slight pains in back and legs. Cheeks slightly flushed, sclerae white, conjunctivae very pale, no injection and no photophobia. Tongue, small and dry with white fur in the middle; edges and tips clean. Gums pale, pharynx normal. No enlargement of superficial lymph glands, no tenderness to palpation in joints or limbs. No rash, no icterus. Pulse good pressure, regular, 70 to the minute; temperature, 102·2°.

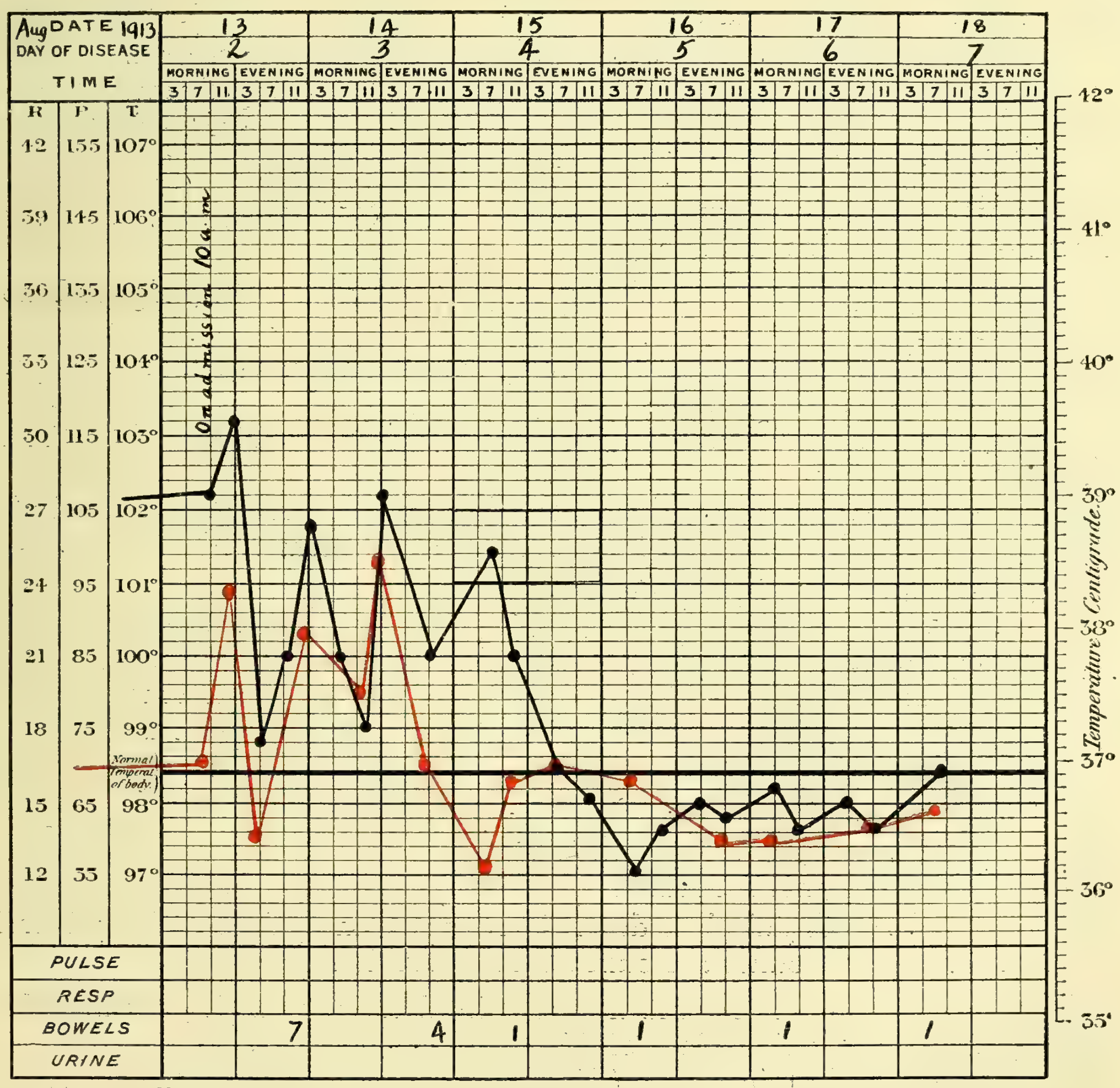


Chart 9

Thorax.—Nothing abnormal found.

Abdomen.—No epigastric tenderness. Liver not palpable, not enlarged on percussion, no tenderness. Spleen not palpable, no tenderness.

Urine.—Sp. gr. 1020, acid, no albumen, trace of bile.

Blood.—Thick and thin films (Giemsa) were taken when patient's temperature was 102·4° and carefully searched. No parasites and no abnormalities of the red cells were found.

Differential count (300 cells counted).

Polymorphonuclears...	86 per cent.
Lymphocytes	7 per cent.
Large mononuclears	7 per cent.
Total leucocyte count	4,900.
Total erythrocyte count	3,900,000.

14*th August*, 1913.—The patient still has some headache, but no other pain, nausea nor vomiting. Pulse rate 80, regular, good pressure; temperature 99·2°. No icterus, patient's face very pale. No epigastric nor abdominal tenderness.

Urine.—Sp. gr. 1022, acid, no albumen, trace of bile.

Blood.—Thick and thin films (Giemsa) were taken when the patient's temperature was 99·2° and carefully searched; no parasites and no abnormalities of the red cells were seen. No '*Paraplasma flavigenum*-like bodies' were observed.

Differential count (300 cells counted).

Polymorphonuclears...	84 per cent.
Lymphocytes	9 per cent.
Large mononuclears	7 per cent.
Total leucocyte count	5,000.
Total erythrocyte count	4,000,000.

Faeces.—Nothing abnormal found.

15*th August*, 1913.—Better, headache less, no nausea, no vomiting, and no abdominal tenderness.

At 6 a.m. patient's temperature was 101·4°, pulse regular, rather soft, 56 per minute. Heart sounds were faint.

At 10 a.m. the temperature was 100°, pulse 68, regular, and improved pressure. Heart sounds distinct.

Blood.—Thick and thin films (Giemsa) taken at 10 a.m. were carefully searched, and one nucleated red cell was seen, but nothing else abnormal.

Differential count (300 cells counted).

Polymorphonuclears...	49 per cent.
Lymphocytes	35 per cent.
Large mononuclears	15 per cent.
Eosinophils	1 per cent.
Total leucocyte count	6,000.
Total erythrocyte count	3,000,000.

Urine.—Sp. gr. 1018, no albumen, no bile.

Faeces.—Nothing abnormal found.

Treatment.—℞ Sod. salicyl. 4 drams, Tr. hyoscyam. 3 drams, Tr. gelsemii 2 drams, Syr. zingib. 1 ounce: 1 ounce omn. quart. hor.

16*th August*, 1913.—Patient much better, headache very slight, nothing else abnormal, except very white colour of skin.

Blood.—Thick and thin films (Giemsa) were taken when the patient's temperature was 98°, and carefully searched, nothing abnormal was found.

Differential count (300 cells counted).

Polymorphonuclears...	35 per cent.
Lymphocytes	44 per cent.
Large mononuclears	14 per cent.
Eosinophils	7 per cent.
Total leucocyte count	8,200.
Total erythrocyte count	4,100,000.

Urine.—Sp. gr. 1020, acid, no albumen, trace of bile.

Faeces.—Nothing abnormal found.

18*th August*, 1913.—No headache. Patient feels well. Looks very pale (says that is his normal appearance).

Blood.—Thin and thick films (Giemsa) were taken when the patient's temperature was 98·2° and nothing abnormal was found.

Differential count (300 cells counted).

Polymorphonuclears...	41 per cent.
Lymphocytes	28 per cent.
Large mononuclears	23 per cent.
Eosinophils	7 per cent.
Total leucocyte count	7,500.
Total erythrocyte count	4,000,000.

Urine.—Sp. gr. 1022, acid, no albumen, trace of bile.

Faeces.—Nothing abnormal found. The patient was discharged to-day. He was given no quinine while in hospital.

Case II

European, aged 39. Alcoholism, albuminuria and jaundice.

17*th June*, 1913.—Admitted to hospital under the care of the Senior Medical Officer. The patient has been eighteen years in the tropics; Congo three years, Cameroons two years, and Gold Coast thirteen years. He was in Accra during the outbreak of bubonic plague. He has had various attacks of 'Fever' and 'Ague,' all of them mild, but for the past five years he has been free from illness. During the last three or four years he has hardly taken any quinine. He has been stationed lately in Sekondi, and went to Tarquah yesterday, but on arriving there felt ill and turned in early, having a restless night, with bad headache. He had neither shivering, sweats nor photophobia. As this condition continued he returned to Sekondi on the following day. Upon his return he vomited three times in the morning and three times in the afternoon. The vomit consisted of bile. When seen at his house by the Senior Medical Officer his temperature was 103°. On admission to hospital the temperature was 102·6°, with a pulse rate of 104.

Treatment.—Low diet.

18*th June.*—On examination the sclerae were tinged with yellow, and the conjunctivae were jaundiced. The teeth were good and the gums pale. The tongue was pointed with a thick white fur all over, the breath was foul, and the pharynx normal. Knee reflexes somewhat sluggish.

Thorax.—Lungs sound. Heart, slight mitral systolic murmur heard.

Abdomen.—Liver not enlarged, no tenderness. The organ reaches the costal margin in the mammary line. Spleen much enlarged and tender, no epigastric pain nor tenderness.

Urine.—Sp. gr. 1024, slight quantity of albumen, bile present in marked quantity.

Faeces.—Normal.

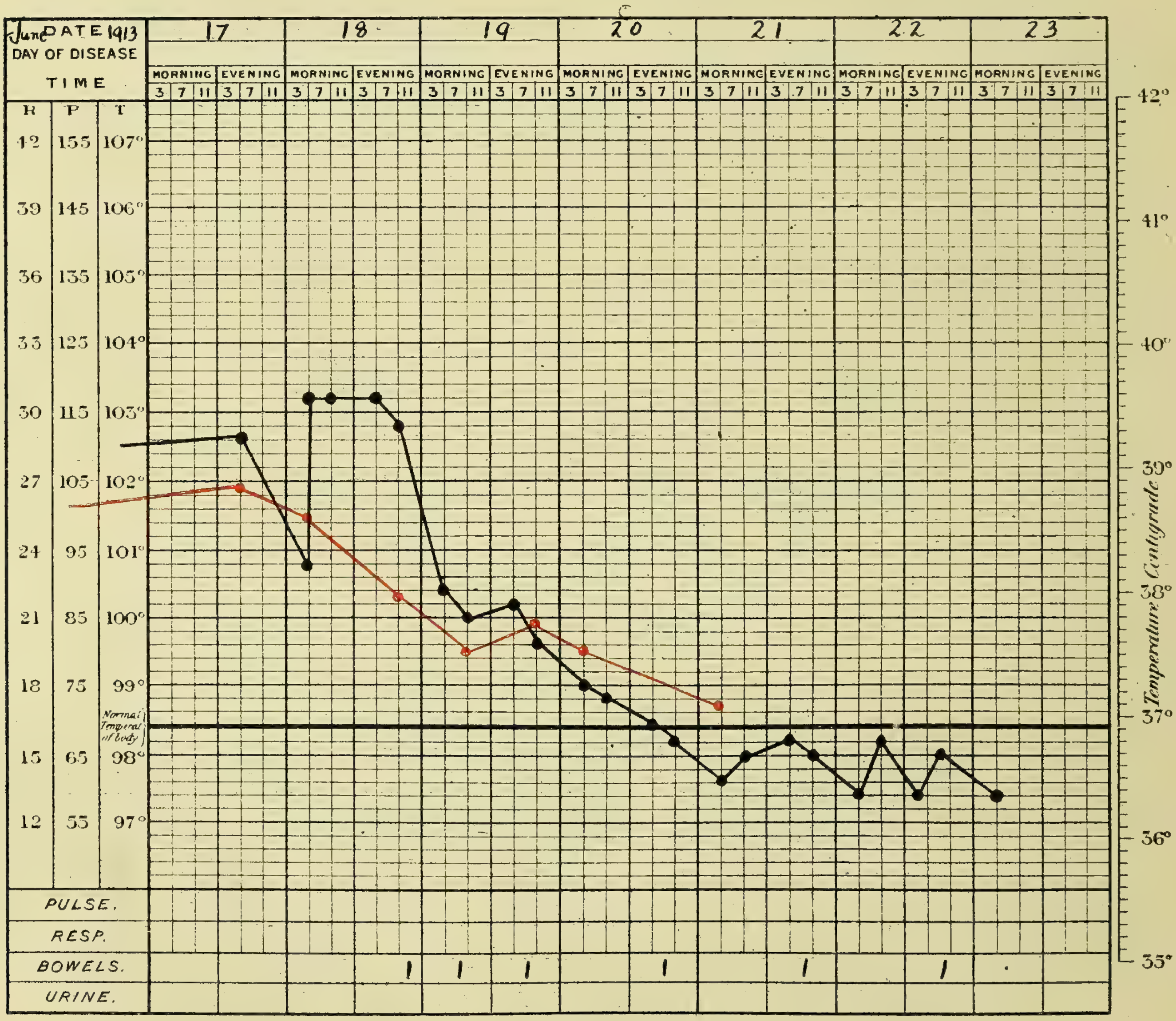


Chart 10

Blood.—No parasites found in thick or thin films (Giemsa), taken at 10 a.m. Differential count (300 cells counted) :—

Polymorphonuclears...	62 per cent.
Lymphocytes	27 per cent.
Large mononuclears	9 per cent.
Eosinophils	3 per cent.
Total leucocyte count	5,250
Haemoglobin	60 per cent.

Treatment.—Mist. quin. 1 ounce mane. ℞ Tr. digitalis 2 drams, Sp. aetheris co. 3 drams, Sp. ammon. co. 3 drams, Syr. zingib. 6 drams, Aq. ad 6 ounces: 1 ounce omn. tert. hor. ex aqua.

19*th June.*—The patient is feeling much better and is able to take food without vomiting. He had a good night, and the headache is better.

Blood.—Differential count:—

Polymorphonuclears...	51 per cent.
Lymphocytes	41 per cent.
Large mononuclears	7 per cent.
Eosinophils ...	1 per cent.
Total count leucocyte	4,500

Urine.—Trace of albumen with slight amount of bile.

20*th June.*—Improvement maintained. Knee-jerks less sluggish.

Blood.—Differential count:—

Polymorphonuclears...	47 per cent.
Lymphocytes	42 per cent.
Large mononuclears	9 per cent.
Eosinophils ...	2 per cent.
Total count leucocyte	5,800

Urine.—No albumen, very slight trace of bile.

21*st and* 22*nd of June.*—Improvement continued, knee-jerks normal, no headache. Patient put on full diet.

23*rd June. Blood.*—Differential count:—

Polymorphonuclears...	58 per cent.
Lymphocytes	31 per cent.
Large mononuclears	7 per cent.
Eosinophils ...	4 per cent.

Patient discharged to-day, cured.

In this case there was evidence of frequent indulgence in alcohol.

RESULTS OF EXAMINATION OF BLOOD AND URINE FROM 126 NATIVE PRISONERS, APPARENTLY HEALTHY, IN CENTRAL JAIL, SEKONDI, MAY AND JUNE, 1913.

No.	Malaria parasites	*Filaria*	Urine
1	Subtertian crescent	—	Normal
2	Nil	—	"
3	—	—	"
4	—	—	"
5	—	—	"
6	—	—	"
7	—	—	"
8	—	—	"
9	—	—	"
10	—	—	"
11	—	—	"
12	—	—	"
13	—	—	"
14	—	—	"
15	—	—	"
16	—	—	"
17	—	—	"
18	—	—	"
19	—	—	"
20	—	—	"
21	—	—	"
22	Subtertian rings	—	"
23	" "	—	"
24	" "	—	"
25	Nil	—	"
26	Quartan rings	—	"
27	Nil	—	"
28	Subtertian crescents	—	"

No.	Malaria parasites	*Filaria*	Urine
29	Nil	—	Normal
30	"	—	"
31	"	—	"
32	"	—	"
33	"	—	"
34	"	—	"
35	Scanty subtertian rings	—	"
36	Nil	—	"
37	Scanty subtertian rings	—	"
38	Nil	*perstans*	"
39	Scanty subtertian rings	*bancrofti*	"
40	" " "	—	"
41	" " "	—	"
42	Nil	—	"
43	"	*perstans*	"
44	Scanty subtertian rings	—	"
45	Nil	—	"
46	"	—	"
47	"	—	"
48	Scanty subtertian rings	—	"
49	Quartan and benign tertian rings	—	"
50	Subtertian crescent	—	"
51	Nil	—	"
52	Quartan rings	—	"
53	Nil	*perstans*	"
54	Benign tertian gametocyte	—	"
55	Nil	*perstans*	"
56	Scanty subtertian rings	"	"
57	Nil	Nil	"
58	Scanty quartan	"	"
59	Nil	"	"
60	Scanty subtertian rings	"	"
61	" " "	"	"

No.	Malaria parasites	*Filaria*	Urine
62	Nil	Nil	Normal
63	,,	,,	,,
64	,,	,,	,,
65	,,	,,	,,
66	Scanty subtertian rings	,,	,,
67	Quartan and subtertian rings	,,	,,
68	Nil	,,	,,
69	,,	,,	,,
70	Scanty quartan rings	,,	,,
71	Nil	*perstans*	,,
72	,,	Nil	,,
73	,,	*perstans*	,,
74	,,	,,	,,
75	,,	Nil	,,
76	,,	,,	,,
77	,,	,,	,,
78	Scanty subtertian rings	,,	,,
79	Nil	,,	,,
80	,,	,,	Albumen present
81	,,	*perstans*	Normal
82	,,	Nil	,,
83	,,	,,	,,
84	,,	,,	,,
85	,,	,,	Bile present
86	,,	,,	Normal
87	,,	*bancrofti* and *perstans*	,,
88	,,	*bancrofti*	Bile present
89	,,	Nil	Normal
90	Scanty subtertian rings	,,	,,
91	Nil	,,	,,
92	,,	,,	,,
93	,,	,,	,,
94	,,	,,	,,

No.	Malaria parasites	*Filaria*	Urine
95	Nil	Nil	Bile and albumen present
96	”	”	Normal
97	”	”	”
98	”	*perstans*	”
99	”	Nil	”
100	”	”	”
101	”	”	”
102	”	”	”
103	”	”	”
104	”	”	”
105	”	”	”
106	”	”	”
107	”	”	”
108	”	”	Albumen present
109	Scanty subtertian rings	*bancrofti*	Normal
110	Nil	Nil	”
111	”	”	”
112	”	”	”
113	”	*perstans*	”
114	”	Nil	Bile pigment present
115	”	*perstans*	Normal
116	”	Nil	”
117	”	*perstans*	”
118	”	”	”
119	”	Nil	”
120	”	*perstans*	”
121	”	Nil	”
122	”	”	”
123	”	*perstans*	”
124	”	Nil	”
125	”	”	”
126	”	”	”

Out of one hundred and twenty-six adult prisoners, twenty-five, or 20 per cent., were found infected with malaria parasites. Only four, or 3 per cent., were found to harbour gametocytes.

Yellow Fever Investigations in the Northern Territories* of the Gold Coast.

On account of information received from the Principal Medical Officer on Saturday, the 11th October, reporting two cases of yellow fever amongst Europeans at Bole, I left Sekondi for that district on the following Monday. On Thursday, the 23rd October, I arrived at Kintampo, just eight days after the death of a European belonging to the Public Works Department, and from what Dr. Tobit, the Medical Officer, told me of the case, I agreed with him that it was a typical case of yellow fever.

Every possible precaution to guard against an outbreak had already been taken by Dr. Tobit, including the burning down of the quarters in which the patient had been at the time of his illness.

Whilst waiting for new carriers, Dr. Tobit kindly took means to collect as many samples of larvae, etc., from all parts of the station as was possible during the two days I remained there. As a result, nine bottles of samples were produced for identification. In not one of these was I able to detect *Stegomyia* larvae or pupae. The percentage of malaria-bearing mosquito larvae was very high, eight out of the nine bottles containing either *Pyretophorus costalis* or *Myzomyia funesta*, the former being the more common of the two.

On Sunday, the 26th, I left for Bole, arriving there on Friday, the 31st, in time to see the two cases before they started for Sekondi, having been invalided by the Medical Officer in Charge.

The same day a constable brought in word to the Commissioner that fifteen natives had died at Larabanga, a village some four days' march upon one of the main roads from Bole. Dr. Telfer, the Medical Officer, and myself therefore left to investigate this on the following Sunday.

Upon arriving at the village, we were informed by the Chief that there had been no deaths there for some months and no sickness for six weeks. A thorough inspection of the village was carried out by us, including a visit to the burial ground, where no evidence of any recent interment was forthcoming. Larvae were collected, but no *Stegomyia* was found amongst the number.

Meanwhile a messenger had been sent into Bole to bring back

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* Map follows p. 729.

the constable who had brought in the report. Upon his arrival, he was interviewed together with the Chief. As they both persisted in their original statements, and we had procured all the information possible, we returned to Bole, bringing in the Chief for the Commissioner to deal with.

In Bole itself, the native village is situated some 350 yards from the European quarters. Between these, and about 200 yards from the latter, are housed the constabulary and their families. No natives, except personal servants, are nearer the Europeans. All native compounds and houses have been visited by us in the hope of discovering any cases of sickness which might not have been reported to the Medical Officer. This was all the more necessary owing to the fact that the average number of patients attending the dispensary does not amount to two a day. Several cases of dysentery were discovered and one of pneumonia, but all others were of a surgical nature.

From a record of those attending the hospital here, and from information gathered from the Dispenser and others, two cases of a suspicious nature were said to have attended hospital in August and September of this year. Both cases were marked as suffering from fever. No further notes of their illness could be found, but by means of their names, the cases were traced to two native policemen, who fortunately were still in Bole. The Commissioner kindly had them brought to the hospital, thus enabling the attached details of their illness—as furnished by themselves and the Dispenser—to be taken down in writing.

It seems a pity that one has to be content with details of their symptoms as gained above, but as the first European complained of being unwell on the 8th of September and his was an undoubted case of yellow fever, I think one is justified in surmising that these two cases were also due to yellow fever and that in all probability the source of the infection originated from them.

Thus the first policeman (Case No. 1), after an absence of nine days, arrived back in Bole from the Wa road on the 24th August, and felt unwell the same evening. The following morning he saw the Medical Officer in Charge.

On the 5th September, the second policeman (Case No. 2) reported himself sick.

On the 8th September, the first European went down with yellow fever, and on the 1st October, the second European, who arrived in the station on the 18th September, and was the last to be attacked by this disease.

After referring to the record of cases attending the dispensary at Bole, the following notes have been taken from the two native cases, which leave little doubt of their yellow fever origin.

The temperature, pulse, examination of blood and urine, have perforce been omitted, as no notes of these cases were found to have been recorded at the time of illness. In fact, the following were only obtained by interviewing the patients themselves.

In both cases the urine was seen by the dispenser, who, from former experience of blackwater fever, was convinced that the colour never at any time approached that associated with the latter disease.

Owing to inability to trace former hospital cases and no notes of these having been recorded, it has been found impossible to go further back than July, 1913, in interviewing those who had previously sought medical assistance.

Case No. 1

A policeman, native of Gyfasi, Northern Territories, Gold Coast. Has been in Bole five months. Is now in perfect health.

History of case as obtained from patient himself on the 19th November, 1913 :—

Patient first felt ill on the 25th August, 1913, and reported himself sick the same day to the doctor. He first complained of frontal headache, associated with a marked rigor, followed by a feeling of heat—' his skin live for hurt him.' Photophobia was also an outstanding feature.

Epigastric pain and tenderness then became marked, and on the second day of illness vomiting set in, especially after drinking (he was unable to take any form of solid food) ; this was at first of a bilious nature, but soon took on a very black character, lasting four days.

His motions were normal in frequency, rather fluid, and mixed with very black matter, finally becoming black altogether.

His urine soon took on a light reddish appearance, but was never black.

No bleeding from gums was noticed. No record of jaundice, temperature, pulse, examination of blood or urine, could be found.

No further details of case could be ascertained from the patient himself.

Patient was discharged cured on the 5th September, 1913.

Case No. 2

A policeman, native of Notori, Northern Territories, Gold Coast. Has been in Bole three months and a half. Is now in perfect health.

History of case as obtained from patient himself on the 18th November, 1913 :—

Patient first felt ill on the 5th September, 1913, and reported himself sick to the doctor the same day. He first complained of a rigor, cold, followed by hot feeling all over. This was associated with marked frontal headache and photophobia. Pains in the back and down the legs followed, but no epigastric pain or tenderness.

Vomiting set in the following day, at first bilious, but gradually becoming quite black in character. He noticed that his gums bled about the same time.

His motions were of a dark colour, becoming almost quite black. His urine soon became of a light red colour, but never dark red nor black.

The hot condition of his skin lasted until the day before he was discharged—that is, six days—and remained constant during this period.

No record of jaundice, temperature, pulse, examination of blood or urine could be found.

No further details of case could be ascertained from patient himself.

Patient was discharged cured on the 12th September, 1913.

The following report was compiled after personal interviews with the chiefs, headmen and others in the Tumu, Wa and Bole districts. Information was also gained in a similar way from numerous bands of native traders, who were to be met with at this time of year, passing through these parts, on their way either to or from French territory, to the north of Tumu.

When dealing with dates and numbers, the figures themselves have been given, where accuracy could be more or less relied upon. The record of time by these people is, however, of a very primitive nature, and getting any definite date or number is correspondingly difficult. When endeavouring to ascertain the percentage of deaths and recoveries in a village from this disease, the answer almost invariably was 'plenty plenty people live for die.' Seldom at first could any definite number be stated, the more so as it was generally a case of remembering what had occurred more than three years ago.

A natural suspicion that there was more behind the questions asked had to be overcome, resulting very frequently in the answer 'No' being given to all enquiries. Under these circumstances it took an appreciable time to arrive at the desired information.

Again, the same answer would almost invariably be given when enquiring as to the presence of sick cases in a village. As a

consequence of this, a hut-to-hut inspection was carried out *en route*, either going to or returning from Tumu, and in the vast majority of cases sick were discovered, though these proved to be of no special interest in the present instance.

When dealing with the symptoms of the disease itself and a question of colour arose, the point was finally settled by the help of various coloured objects, to which the informer was asked to point.

No leading questions were asked, the native being exceedingly quick to anticipate any desired answer.

As a result of these enquiries, it would seem that a disease similar to yellow fever is known by the greater number of people in these districts. It is described as being associated with fever, very marked frontal headache (great stress was laid on this), photophobia, epigastric pain, vomiting—at first of a bilious material, later turning to black—and a very high mortality (the lowest being about 40 per cent. and the highest 100 per cent.). Sclerae and conjunctivae were by some described as yellow. Melaena was mentioned on several occasions, as was also a slight red coloration of the urine, whilst bleeding of the gums was given as a symptom by three natives who were rather more intelligent than their fellows. Death occurred within six days.

The disease is known under several names by various tribes (the spelling is phonetic):—

'Poorbagga,'	meaning	'Sick for belly,'	by Moshi people.
'Takassi,'	,,	'The bad sickness,'	,, Walla and Grunshi people.
'Mnu,'	,,	'The bad sickness,'	,, Grunshi people.
'Yauwaozunu,'	,,	'Black vomit,'	,, Grunshi (French) people.
'Tunquio,'	,,	'The bad sickness,'	,, Hausa people.
'Torre,'	,,	'Vomiting and headache,'	,, Hausa people.
'Zumarra,'	,,	'Bad head,'	,, Dagarti and Lobi people.
'Sulparri,'	,,	'Bad head,'	,, Dagarti and Lobi people.

With the exception of four old chiefs, the disease was never heard of in the Northern Territories prior to 1910. All, without exception, declared that it had never been seen or heard of since. The epidemic lasted at each village about two months on an average. No native drug appeared to be of any avail in combating the disease.

That isolated cases of yellow fever do occur amongst the natives is, I think, certain. In no other way could an outbreak such as occurred at Bole be accounted for. In this instance, the source of the infection was traced to a native constable, and, through him, back to one of the villages in which he slept during the nine days he was absent from Bole. A thorough investigation of these villages, and interviews with the chiefs and others, failed to trace it further. It was not until nearing the completion of these enquiries that a possible cause for this failure presented itself, namely, the apathy and want of interest manifested by the people themselves in anything pertaining to disease or death, unless occurring in unusually large numbers. Isolated cases call forth no comment.

It would appear that the cause and symptoms are never discussed—they are immaterial—the case died and there the matter ends. Should the relatives be asked the cause of death, or what the deceased complained of, probably the only reply forthcoming will be that he died of fever, or because 'his belly or head live for hurt him,' whichever the case may be. They may hazard the information that there was vomiting, but the colour of the vomit will not have attracted their attention. Hence a case of yellow fever might easily occur under these circumstances—even more than one—and yet the fact passes without any notice being taken of it.

On the other hand, should the disease become epidemic in character and numerous deaths occur, the natives become uneasy, discuss the matter amongst themselves, and may then solicit the help of the white man.

With regard to the source of the 1910 *infection*

The general belief is that the disease was brought south from Moshi country, Senegal, in 1910. The month of its appearance there is given by Kabah, a native of Leo (Grunshi), Senegal, where he was at the time, as early March. He was certain it was not later; others have also corroborated this. The town of Wagadugu is stated to have been the chief centre of the disease. From here Moshi traders carried it west through the Wangara country, many dying on the way. Gilaso was given as the chief town affected.

Following the usual trade route south into Grunshi country (French Grunshi), the town of Leo was reached early in April. Here seven people died, none recovering. Leng is the last village on the French side. All who were attacked there died. Crossing over into the Northern Territories in May, it attacked several villages round the town of Tumu, which, however, escaped, as did also Kopilima, the only village separating Tumu from Leo. The reason Kopilima escaped was due to the chief warning his people not to communicate with Leng. Why Tumu escaped could not be ascertained. Continuing its progress south, the following villages in their order were either attacked or passed over.

Gwong. Many were infected here during the month of May, the greater number of whom died. Exact numbers could not be gained. The duration of the epidemic is also doubtful. Apparently it was not longer than three months. The chief recognised this disease as similar to one which attacked this part of the country when he was a young man, that is, about 30 (?) years ago, when large numbers died. It lasted many months. No others had seen this before.

Nanpobie escaped, though the people heard of it from Gwong, Nandaw and Mossi country. The chief remembered his father talking of a sickness which killed 'plenty, plenty' people 31 (?) years ago in Nanpobie. This was the same disease. With this exception, nobody had heard of it prior to 1910.

Sekai also escaped. The people heard that many died at Sukolu, also north of Tumu. The month could not be stated.

Sukolu. Starting in May, the disease lasted two months, killing all who were attacked to the number of twenty. It came from French country (Senegal). Seven (?) villages, east and west of the main road, were attacked. The names of these were given, such as Bendi, Sentia, Gigan—12 miles west—and Dasima—16 miles west—being also the furthest away. (The chief of the latter village and others near flatly denied that this village had been attacked. From this and other cases, it became evident that, as a rule, too much reliance could not be placed on evidence unless obtained from representatives of the villages themselves, or after the report has been confirmed.)

Bowbellie. This village was attacked in June. There were

twenty-four deaths and two recoveries. Five other villages were attacked. Amongst these were Bendi, Sentia, Gigan and Sukolu. The disease was brought from French country by Moshi traders.

Wallenbelle escaped, probably owing to the chief warning his people not to go near the villages suffering from the disease. Heard of it at Bowbellie and two other villages, in one of which eight people died and one recovered. Does not know the name of the sickness. It lasted two weeks (?).

Wahabu. The first village in the Wa District escaped, though three villages near were attacked, the furthest being about seven miles away. It made its appearance in July and lasted three months. Many died; only a few recovered.

Somor was passed over, though Duluboi and Kujoperi were heard to have had this sickness. Name unknown.

Duluboi was visited by the sickness in July. It lasted one month. Three villages, the furthest being Kujoperi about four miles away, were also attacked. Here again, Moshi traders were held responsible for the outbreak. There were more deaths than recoveries.

Kankillanbassie. The outbreak here appears to have been the most severe of all. It is a large village, and the deaths numbered roughly a hundred, out of a population of about four hundred, with only two recoveries. One of these, a boy whom I saw and who was about ten years of age, became deaf and dumb as a result (?). This was at the end of July, and the epidemic lasted three months. They saw several Moshi traders attacked with black vomiting outside the village, and two of them died. About ten days after these deaths, the villagers themselves began to show symptoms of the disease.

Menyon was attacked at the same time (end of July). Five cases died and three recovered. This was also attributed to a Moshi trader who died of the same sickness, outside the village. It disappeared after two months. Three other villages were also attacked a short distance away.

Nasa escaped, though they heard of three villages, including Menyon, being attacked. Wa town escaped. The disease was heard of in 1910 as having attacked the Tumu District.

Bamako escaped. The disease has never been seen or heard of.

Tanina. The people here only heard of the disease through Moshi traders, who informed them of its having carried off many people in their own country.

Galbo escaped. They never heard of it having been seen.

Ga Ga escaped. Traders spoke of it as occurring in Wagadugu.

Kulmasa escaped. It has never been seen or heard of. (This village is the first in the Bole District.)

Pungre escaped. Moshi traders informed them that 'plenty people' died of this in their own country.

Y'pala. The town never saw or heard of the disease.

Tuna was attacked in the beginning of August; five people died and three recovered. Three villages near Tuna were also infected. The chief remembers a similar disease, which attacked the country some 30 years ago (?). His father also told him that when he was a young man he had also seen this disease, and that 'plenty, plenty' people died as a result. It came from the North French Territory, and in both instances lasted a year (?). In the present case (1910) it lasted one month.

Nakawbi had five people infected, of whom four died and one recovered. Two villages were also attacked, one being Tuna. It made its appearance in August, and lasted one month.

Sawla escaped. Heard about it from the traders.

Mankama has never seen or heard of such a disease.

Bole Town. The disease was only heard of as occurring in French country (Senegal) and in the Wa District; otherwise, never seen or heard of. At *Duluboi,* a Hausa trader stated that a similar disease appeared in *Kano,* Northern Nigeria, during July, in 1910. It was called 'Tunquis' by the people there; many died. In his village, where he was at the time, fifteen people were attacked, five of whom died. It was regarded as a new disease. He had never seen or heard of it again, nor could he give any suggestion as to its origin. The headman of certain Moshi traders met with at the same village said their country was attacked early in March. The chief town, Wagadugu, where they were at the time, suffered most. Could not give numbers, though 'plenty, plenty' people died; there were many more deaths than recoveries. The disease lasted two months in Wagadugu itself. In his country, the disease is called 'Poorbagga,' but he could not say whether it was a new disease. He had never seen or heard of it since.

The Moshi people (over a thousand were quarantined at Tumu) could give very little information, and gave as a reason the fact that their occupation of trading to the coast and back prevented them from hearing much of what was going on in their own country. The disease had not been heard of since 1910. They could not say if it was regarded as a new disease. At *Gar*, three Wangara headmen stated that the disease came to their country in March, 1910, for the first time. Moshi traders brought it, some dying on their way through the Wangara country. As the latter people had no name for this disease, they borrowed the Moshi name 'Poorbagga.' They had never seen or heard of it since.

In the Tumu District, all the outlying chiefs and their headmen came into the station to be interviewed. *Nebiowalli*, about 32 miles south-east of Tumu, was the furthest east to be affected. The chief heard of the disease near Tumu, never from the eastern side. Has never heard of it before or since. It came from French country (Senegal). No village near him was affected.

An old chief from *Pina*, 16 miles east of Tumu, said it came to his part of the country 30 (?) years ago, and again 30 (?) years before that, in his father's time. In both cases it lasted one year (?). The country was then German. It did not attack his village in 1910.

Nandaw, some 30 miles south-west of Tumu, was the furthest west the disease reached. All the chiefs stated that their villages had escaped the epidemic; most of them had never even heard of it. The same may be said of the rest of the Wa and Bole chiefs, with the exception of those mentioned above.

Even those who came to be interviewed from near the Ivory Coast border had never heard of such a disease. It will thus be seen that, with the exception of Tuna and Nakawbi in the Bole District, the disease had never been seen further south than Menyon, which lies about 16 miles north-east of Wa town.

The north-eastern part of the Northern Territories, peopled by the *Mamprussi*, *Kanjarga*, *Eastern Grunshi* and *Dagomba* tribes, as far as can be gathered, has never been attacked by this disease.

Case No. 3

Native. Yellow Fever. Bole.

This should have been included with the two other native cases at Bole. As, however, the man was away from Bole, on duty, at that time, he could not be examined, nor was there then any reason to suppose that his had been a case of yellow fever.

The following is a history of his case as furnished by himself on the 6th January, 1914 :—

A constable, native of Twaishi. Has been in Bole for a year and a half.

On the 18th September, left Bole on duty, slept the same night at Suripe, and returned to Bole the following day. On the 20th he felt unwell, and on the 21st attended the hospital.

He first of all complained of general malaise, quickly followed by rigor and 'his skin burn him.' About the same time his head became very bad in the frontal region, together with pain at the back of the eyes, worse on opening them to the light. No inclination for food, but on drinking water, he vomited contents of stomach. The vomiting continued, becoming bilious in character. Towards the end of the second day it began to get black in colour. 'His belly live for hurt him.' He described melaena as being present and his urine of light red colour. Could not say what the colour of his sclerae and conjunctivae were. His throat, mouth, and gums were painful; the latter were swollen, but he did not observe whether they were bleeding or not.

No further details of this case could be ascertained.

Case No. 4

Native.

On my return to Bole, Dr. Telfer, the Medical Officer, informed me that, during my absence, a native case of yellow fever occurred in Bole on the 8th December. Little was known of the man's antecedents. All that could be gathered was that he had come from Kintampo. The number of days he was in Bole prior to his illness is very doubtful. It would appear to be from seven to ten days, but this cannot be relied upon. As the case proved fatal, it is impossible to trace the origin of the disease. From personal inspection by Dr. Telfer and myself, the town of Bole is apparently free of any infection having the slightest resemblance to yellow fever. A report* of this case has been forwarded by Dr. Telfer to the Principal Medical Officer, Accra.

The following is a report on another case of yellow fever, which occurred prior to my arrival in Tumu, and was attended by Dr. Ryan :—

Case No. 5

1st day.—Went sick at 9 a.m. on Saturday, 15th November, 1913. Appearance : keen, alert, due to marked suffusion and brightness of the eyes and contraction of pupils, sclerae clear, normal colour. Patient had taken quinine gr. 15.

Subjective symptoms.—Pains in musculature of chest described as severe. Headache acute and described as though daggers were piercing the temples. No abdominal pain.

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* Not received by the Commission.

Physical condition.—Eyes bright and markedly suffused ; tongue slightly furred ; skin clear, dry, and hot to the touch. Heart and lungs normal ; liver normal. No epigastric pain nor tenderness. Spleen not enlarged. Urine, sp. gr. 1020. Reaction acid. Albumen nil. Deposits nil, temperature 102·4°, pulse 100, of good quality.

4 p.m. Condition unchanged. Patient very restless and complaining of the severity of the headache. Temperature 102°, pulse 102, quinine, gr. 10, given. Slight delirium, not sleeping.

7 p.m. Restlessness, sleeplessness, and headache continue. Temperature 101·8°, pulse 88, of good quality. Suffusion and brightness of eyes less marked. Pains in the chest disappeared. No epigastric pain nor tenderness.

Quinine, gr. 10, and calomel, gr. 5, given with hot drink, after which skin acted well.

10 p.m. Restless, sleepless, and complaining bitterly of headache. Aspirin, gr. 10, given, but with no satisfactory result. Skin moist. Eyes heavy and dull, in marked contrast with their appearance in the early part of the day.

2 a.m. Calomel acted with slight vomiting.

3 a.m. Temperature 99·2°, pulse 88. Patient again vomited on going to stool—ordinary bilious vomit.

3.30 a.m. Again vomited, greenish black substance, headache intense. At 3.45 bowels opened.

6 a.m. Again vomited, no discolouration noticeable. Temperature 99·4°; pulse 86, of good quality. Headache intense, as are also the restlessness and sleeplessness. Urine normal. Blood examined. No malaria parasites, large mononuclears 18 per cent. Champagne, 2 ozs., given and later milk and brandy.

2nd day.—9 a.m. Temperature 99·8°, pulse 86, Brand's Essence given, later Aspirin, gr. 10, followed by quinine, gr. 10. No vomiting, patient still complaining of headache, very restless and sleepless. Skin dry and burning. Tongue slightly furred.

11 a.m. Temperature 100·8°, pulse 92, full and bounding, milk and ' Sparklet ' to drink. Patient absolutely sleepless, restless, and suffering from the severity of the headache. Skin dry and burning.

1 p.m. Temperature 101·2°, pulse 96, Aspirin, gr. 10, with hot whisky and milk given. Patient very restless ; all suffusion from eyes disappeared.

3 p.m. Temperature 101·44°, pulse 100, no vomiting. Headache and restlessness undiminished.

5 p.m. Temperature 102·4°, pulse 100. No change in condition. Quinine, gr. 10, intramuscularly. Champagne and brandy given.

7 p.m. Temperature 102·4°, pulse 98. Skin dry and burning. Headache and restlessness continue undiminished.

9 p.m. Temperature 102·8°, pulse 102, of good quality. Skin clear, sclerae clear. No vomiting. No delirium. Wakeful and restless. Phenacetin, gr. 10, given, followed by Trional gr. 20, with hot milk and whisky.

1 a.m. Temperature 102·8°, pulse 100. Sleepless and restless. Respirations 28, gasping just before expiration as in broncho-pneumonia. No delirium. Patient perfectly alert. Whisky and hot milk again given, followed by two hours' broken sleep.

4 a.m. Temperature 103°, pulse 102, condition unchanged, brandy and champagne given.

6 a.m. Temperature 103°, pulse 100, no delirium, no jaundice, no discolouration of sclerae, no rest, no sleep, skin dry. Headache severe, tongue small and coated, edges clean. One egg beaten up with milk and brandy given.

8 a.m. Temperature 103·4°, pulse 100, of good quality, full and strong. Complaining bitterly of headache and discomfort of dry skin. Sclerae slightly bloodshot. No jaundice. The following given :—

℞ Sodae salicyl	gr. 15
Pot. bicarb.	gr. 15
Ammon. brom.	gr. 20
Spt. aether nit.	♏ 15
Liq. ammon. acet.	♏ 20
Tr. hyoscyam.	♏ 15
Aq. ad.	2 drachms

Ft. haust.

3rd day.—No reaction. Urine for previous twenty-four hours : sp. gr. 1030, acid (strongly), albumen 0·4 per cent., no deposit.

11 a.m. Temperature 103·8°, pulse 102. Sternberg's mixture given, and champagne, 2 ounces. Patient drinking fair quantity of 'Sparklet' and plain water. Headache persistent and severe. Patient tossing about and moving from bed to long-chair.

1 p.m. Temperature 104°, pulse 105. Condition unchanged, bowels opened, normal coloured motion.

2 p.m. Skin acting slightly, temperature 103·4°, pulse 100, frontal headache marked. Spleen and liver apparently normal. No tenderness, epigastric nor otherwise ; no pain anywhere save in the head.

4 p.m. Temperature 104°, pulse 96. Tongue slightly coated, clean at the edges and tip. Headache very troublesome.

Feet bathed in hot water and mustard, and a similar draught to that of the morning administered. Thirst not urgent. A slight jaundice of the face showing. Urine scanty, very acid, and loaded with albumen.

6.30 p.m. Temperature 104·2°, pulse 96, fair quality. Slight regurgitation of about a mouthful of stomach contents, not discoloured. Skin extremely dry, harsh, and hot. Pilocarpine nitrate gr. ¼ given hypodermically. Headache severe. Restlessness not so marked.

8 p.m. Temperature 103·6°, pulse 87. Vomited at 7.30, a little semi-digested milk and much clear fluid. Profuse perspiration followed the pilocarpine, and patient passed about six ounces of urine.

9 p.m. Temperature 104·2°, pulse 97. Restlessness not so acute, but patient absolutely wakeful. Headache severe. Feet again bathed in hot water and mustard. Skin dry and hot. Thirst becoming urgent. During night patient became much less restless, but still sleepless. Thirst marked, consumed large quantities of a modified Sternberg's mixture, viz., Sod. Sulph. ad Sternberg, and the amount of urine increased largely. Bowels opened twice.

6 a.m. Temperature 103°, pulse 78. Headache gone. Patient exhausted and lying resting drowsily.

9 a.m. Temperature 103°, pulse 86, of good quality. Tongue small, coated lightly, and clean at the edges and tip. Sclerae muddy and injected, eyes bright and glowing.

4th day.—Urine 38 ounces, acid, sp. gr. 1025, albumen 0·15 per cent. Patient much more restful, and headache now only present as a feeling of fullness and congestion. Slight epigastric tenderness (?). No vomiting. Heart and lungs sound. Sternberg's mixture, milk and 'Sparklet.' 'Sparklet' alone. Cold champagne in sips only allowed.

11 a.m. Condition unchanged, temperature and pulse as before, 1 p.m. passed water.

2 p.m. Temperature 103·6°, pulse 88. Patient quiet, snatches of sleep. Headache has returned. Eyes very injected. Sclerae discoloured with yellow tinge, also slightly noticeable in skin.

4 p.m. Temperature 103·2°, pulse 89. Patient very weak, perfectly restful but wakeful. Sclerae distinctly yellow. Eyelids congested and mucous membrane dark red in colour. Headache present, but not severe. Tongue, dorsum coated slightly, edges clean. Photophobia, which has been present almost from the onset of the disease, is now marked. Yellowish tinge showing in skin over eyebrow and up to the temple, and between the eye and wing of nose. Face very drawn. Mind perfectly clear. Dyspnoea with increased respirations before noticed, has now almost subsided.

5 p.m. Temperature 103·6°, pulse 94, passed urine.

6 p.m. Temperature 103·8°, pulse 84. Sweating (Phenacetin gr. 10 given at 5.15 with hot tea).

7 p.m. Temperature 103°, pulse 88. Sleeping.

8 p.m. Temperature 101·8°, pulse 78. Patient drowsy and slightly delirious, quite free from restlessness. Bowels opened and passed urine 10 ounces. Motion normal in colour and very liquid.

12 midnight. Temperature 102·6°, pulse 81. Patient vomited clear fluid once. Blood-clots present in nasal passages, tenderness (?) over liver and stomach.

6 a.m. Temperature 102·6°, pulse 79, bowels opened three times during the night; bile coloured, watery motion, very evil smelling, large quantities of urine passed, dark amber-coloured.

8 a.m. Temperature 102·6°, pulse 80, bowels opened, clear fluid. Whole body anointed with olive oil, no increase in the jaundice of the body, but in the sclerae well marked.

5th day.—10 a.m. Temperature 102·8°, pulse 80. Weak. Bowels opened, bile coloured, watery motion. Passed urine. Urine for past twenty-four hour:—

82 ounces; sp. gr. 1015; reaction, strongly alkaline (due partly perhaps to decomposition), albumen 0·2 per cent. Patient very weak and in no pain; fresh specimen of urine strongly alkaline.

10.30 a.m. Patient vomited and bowels opened, motion of greenish-coloured water, alkaline in reaction. Icteric tinge, very noticeable in skin of body. Patient only on Sternberg's mixture and weak alkaline drinks, with sips of champagne occasionally, and at other times weak brandy and alkaline water. Tongue small and triangular, with bright red tip and edges, dorsum slight grey coating.

Patient passing much greenish water per rectum.

1 p.m. Temperature 102·6°, pulse 86. Weakness a little less than during the early part of the morning. No vomiting, and activity of bowel less insistent. Sternberg's mixture discontinued *pro tem.* and plain cold water only allowed. Sleeplessness acute. Patient has not had ten hours' sleep altogether in the past four and half days.

3 p.m. Temperature 103°, pulse 80. Skin dry and harsh.

Phenacetin gr. 10 given with hot weak tea. Tongue bright red, with very slight area of coating, and that far back. Mouth dry, with dryness of the lips, suggesting the state preliminary to the appearance of sordes. Patient sleepless and restless.

5 p.m. Temperature 102·8°, pulse 84, of better quality than earlier in the day, sweating easier, bowels opened once, watery, slightly tinged with bile, no vomiting. Tenderness over stomach, liver, etc., not present. Patient restful and out of pain. Milk largely diluted with alkaline water and 'Sparklet' allowed.

7 p.m. Temperature 102·8°, pulse 80, hot mustard foot-bath (3 min.) given.

8 p.m. Temperature 101·8°, pulse 96. Patient very quiet and slightly drowsy. Patient passed drowsy night, occasionally sleeping for half an hour, bowels opened three times, watery, very slightly tinged with bile.

6 a.m. Patient on the whole easier than at any previous time since the onset of the disease. Tongue small, bright red, scarcely any coating save far back. Icteric tinge of skin not increased.

8 a.m. Temperature 103·8°, pulse 82. Skin dry, slight irritating cough, whole body anointed with olive oil. Bowels opened, creamy, evil smelling motion. Urine for past twenty-four hours :—

65 ounces, sp. gr. 1025, alkaline, albumen 0·2 per cent., no deposits, no discoloration.

6th day.—12 midday. Temperature 104·2°, pulse 84, strong and bounding. Weak brandy with 'Sparklet' and a little milk allowed, also Sternberg's mixture (dilute) ad lib. Phenacetin gr. 10 given and quinine gr. 10 intramuscularly.

1 p.m. Patient sweating profusely, strength wonderfully maintained, very weak. Brandy and milk mixed with Sternberg's mixture and 'Sparklet' allowed, also as much 'Sparklet' and plain water as patient desires. Temperature 104°, pulse 88.

3 p.m. Patient still sweating profusely. Temperature 103·8°, pulse 88. Icteric tinge deepening. No tenderness over any part of the abdomen. Pupils markedly dilated in contrast with their contraction in the early days of the disease. Pulse compressible but not markedly so.

5 p.m. Temperature 104°, pulse 86. Sweating ceased, no real sleep. Drowsy and slightly delirious.

7 p.m. Temperature 104°, pulse 84. Fuller and softer than at 5 o'clock, taking plenty of fluid, strength on the whole wonderfully maintained. Delirium increasing.

8.30 p.m. Temperature 103·8°, pulse 90. No change.

5 a.m. Temperature 103·8°, pulse 84, weak and running. Patient delirious, somnambulistic and kept in bed with difficulty. During the night bowels opened three times, clear watery motions. No vomiting.

7 a.m. Temperature 104·4°, pulse 88. Delirium marked.

8 a.m. Temperature 103·6°, pulse 90. Twitching of muscles marked, and plucking at the bedclothes. Urethra irritable when water passed.

7th day.—10 a.m. Temperature 102°, pulse 96, of slightly better quality, but very weak. Extremities warm, and surface temperature well maintained. Profound delirium. Subsultus not so marked. Urine for previous twenty-four hours probably more, alkaline, sp. gr. 1025, albumen 0·25 per cent., colour dark amber.

12 midday. Temperature 104°, pulse 100. Weak and running, slight

sweating; otherwise condition unchanged (12.15, temperature 103°, pulse 104; 1 p.m., temperature 101·8°, pulse 104).

2 p.m. Temperature 102°, pulse 100. Very weak, surface heat good, sweating freely, very delirious, carphology, sordes on tongue and lips, with slight bleeding from the gums, subsultus present. Pulse very compressible. Patient taking large quantities of liquid, weak brandy and water given every two hours.

3.30 p.m. Temperature 105°, pulse 104. Muscles twitching to such an extent that pulse is difficult to count (I doubt accuracy of two previous temperatures as I attempted to take them in the mouth, but lips were not quite closed), sweating profusely since 12.30, with low muttering delirium. Skin emitting characteristic odour. Absolutely sleepless.

5 p.m. Temperature 103°, pulse 103. Still sweating and condition unchanged.

7 p.m. Temperature 103·6°, pulse 112. Condition still unchanged, except for the worse. Delirium becoming maniacal in type. Pulse soft, but each beat well marked (*i.e.*, not running). Anuria. Bowels have not opened since morning.

9 p.m. Condition unchanged, delirium lessening.

11 p.m. Temperature 103·2°, pulse 110. Anuria.

4 a.m. Cheyne-Stokes respirations (type of) slightly marked. Temperature 103·2°, pulse 126. Heat of surface well maintained, still sweating freely.

6 a.m. Temperature 103·2°, pulse 130, scarcely perceptible at wrist. Strych. sulph. gr. 1/15 hypodermically, and one pint saline containing brandy 2 drachms given per rectum. Sinapisms placed over loins. Anuria.

6.30 a.m. Saline repeated. Both salines retained for about ten minutes. Anuria not absolute, as patient in his delirium has been passing small quantities of urine under him during the night unconsciously, bowels have opened similarly; motion white and evil-smelling. Nursing a matter of much difficulty, owing to the mania of the patient. This remark refers to the early part of the night. Patient has now been in an apparent sleep for some hours.

7 a.m. Patient slightly better. Cheyne-Stokes respiration has disappeared; temperature 103°, pulse 128; cannot get pulse at wrist owing to its weakness and the muscular twitchings.

8 a.m. Temperature 104°, pulse 135. Cheyne-Stokes respiration. Energetic treatment as for shock; foot of bed raised; hot bottles to feet and over heart, saline every half-hour. Strychnine subcutaneously. Patient cannot swallow; surface temperature well maintained, sweating profusely. Anuria absolute.

8th day.—12 midday. Temperature 103·8°, pulse 124, weak, running, scarcely obtainable at wrist, but of much better quality than in the morning. Phenacetin co. gr. 10 given per rectum and afterwards saline containing brandy 2 drachms. Patient in a comatose sleep since 3 a.m., when the active delirium ceased. No vomiting.

2 p.m. Temperature 106·2°, pulse 140. Body rubbed with olive oil vigorously. Temperature 104°, pulse 120.

2.30 p.m. Temperature 106°, pulse 139. Phenacetin co. gr. 10 and Spt. aether. nit. given in rectal saline. Temperature fell to 105° and pulse became slightly steadier.

3.30 p.m. Profound coma, temperature 107°, pulse 145. Body bathed in a profuse sweat. Cheyne-Stokes respirations well established.

Various expedients resorted to, to bring down the temperature and to re-establish some semblance of strength, but all to no purpose.

Patient died at 5 p.m. Temperature at death 106·2°. Slight convulsions, uraemic in type, marked since midday.

Post-mortem examination held 23rd November, 1913, 7 a.m.

Body mottled by subcutaneous discoloration, dependent parts show deep post-mortem staining.

Abdominal cavity. Stomach containing small quantity straw-coloured fluid, mucous membrane congested, becoming dark purple toward the pylorus. Pylorus and duodenum darkly congested. Liver yellow, not obviously enlarged, elastic, resilient consistency. Spleen very soft but not apparently enlarged. Kidneys enlarged and dark red in colour.

W. A. Ryan,
Medical Officer.

During the carrying out of these investigations, the kind help and co-operation—wherever possible—of the following Officers has been of great assistance:—

Bole. Dr. Telfer, Medical Officer.
,, Mr. M. G. S. Sheriff, Acting District Commissioner.
Wa. Mr. H. M. H. Berkeley, Provincial Commissioner.
Tumu. Dr. W. A. Ryan, Medical Officer and Acting Commissioner (temporary).

H. S. C.

Report on Work at Sekondi, from 1 October, 1913, to 30 April, 1914.

No cases of yellow fever have been observed in Sekondi during the period October, 1913, to April 30th, 1914.

In October, 1913, a native suspected of suffering from yellow fever* was sent into Sekondi from the Inchaban Water Works by Dr. G. P. G. Beckett. This case turned out to be one of acute streptococcal septicaemia. It presents certain points of interest in the differential diagnosis of yellow fever, and details of the case, clinical phenomena, haematological, bacteriological and histological records with post-mortem findings are appended. Investigations at Inchaban were carried out by Dr. Lorena, Medical Officer of Health, and Dr. Beckett. No suspicious cases had occurred there previously, nor did any turn up subsequently. In November, 1913, another case suspected of being yellow fever occurred in Sekondi. This case, a native clerk, Gold Coast Government Railway, was treated in the Native Hospital. The case was one of severe gastritis. Albuminuria was never present, nor did the course of the illness suggest yellow fever.

With the help of Dr. Lorena, observation was kept on the inhabitants of his house and those near by. There had been no suspicious cases of illness there previously, nor did any occur subsequently. No mosquitoes or their larvae could be found about these houses at this time.

During the period dealt with in this report, cases of yellow fever have been notified from Lagos, Saltpond and Accra. All arrivals at Sekondi from these places have been kept under observation by Dr. Lorena, who kept me informed of such arrivals and assisted me in their periodical examination. In this matter, as in all others appertaining to this investigation, Dr. Lorena has given the greatest assistance to and co-operation with the Investigators.

No cases of illness in any way suspicious of yellow fever occurred among such arrivals or in the neighbourhood of their dwellings. If deaths occurred among them, post-mortem examina-

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* For clinical notes and post-mortem findings of this case, *vide* pp. 719-721 *infra*.

tions were demanded by the Medical Officer of Health and carried out by me.

In fact, in all cases of illness terminating fatally that had not been attended by a registered Medical Practitioner, post-mortem examinations have been requested by the Medical Officer of Health and carried out by me. In only one case was any sign noticed suggestive of yellow fever.

In this case, the liver was found to have undergone marked fatty degeneration. There were no other signs indicative of yellow fever, and the condition of the liver was readily explained on finding a heavy infection with *Necator americanus* and *Ankylostoma duodenale*—some hundreds of these worms being removed. The urine in the bladder did not contain albumen.

On several occasions reports reached the Medical Officer of Health that unusual sickness, with some deaths, had occurred in Adjuah, Dixcove, and the intervening villages. On these occasions I accompanied Dr. Lorena to the places mentioned, and with him carried out an enquiry on the spot. The rumours always proved to be false.

No cases of fever then, nor history of recent fever, could be discovered—special attention being paid to the children.

In Sekondi itself from time to time the Medical Officer of Health's Inspectors reported to him cases of fever or sickness occurring among the natives, such cases neither being attended by any registered Medical Practitioner nor seeking treatment at the native hospital.

Dr. Lorena informed me promptly of all such, and permitted me to accompany him in order to examine personally these cases. Search was always made for mosquitoes and larvae, both in the houses and yards of the sick and in those near by, and careful enquiry made as to other cases of illness, especially among the children, as many as possible being examined. No sick children were ever found. On no occasion was any possible indication of yellow fever obtained, and mosquitoes and larvae were, if not always absent, always very scarce.

With the exception of the case already mentioned, no cases have occurred among those admitted to or attending the European and native hospitals either suspicious of yellow fever or

presenting any symptoms of interest or value as regards its differential diagnosis. No account of these cases is therefore appended.

It may be noted, however, that four cases (three natives and one European) of malarial fever with albuminuria occurred, the albuminuria ceasing quickly with the disappearance of the parasites.

The European case was of interest in that the patient admitted to hospital for diarrhoea, after three days in bed with normal temperature, suddenly developed fever, occipital headache and albuminuria. A decidedly scanty subtertian malarial infection was discovered on examining his blood. The infection, though undoubtedly present on his admission to hospital, had been scanty enough to be missed by the ordinary method of blood examination, i.e., of a thin blood film—the only method that had been used in this particular case. All symptoms rapidly disappeared on the administration of quinine, and with the exception of the fever and slight albuminuria, lasting one day, there were never present any signs suggestive of yellow fever.

Besides researches on actual cases of yellow fever, should such occur, one of the main objects of the Investigators was to endeavour to elucidate, so far as in them lay, the question of the endemicity of yellow fever in whatever part of the Colony their investigations should lie.

A well-known writer on yellow fever placed on record the opinion that the West African native is as saturated with yellow fever as he is with malaria. However true this may have been for West Africa in general in 1910, one may well hesitate to endorse it for Sekondi, in particular, in 1913-14.

At the outset one is faced by the fact that the main points concerning the epidemiology and endemiology of yellow fever are still imperfectly known. It is known that the disease can be conveyed from man to man by *Stegomyia fasciata*; that in places where yellow fever is continuously common, the newcomer is attacked, while the adult native of the place escapes; that in these places children suffer from the disease; that the immunity conferred by an attack is high, if not lasting.

The indicator of the constant presence of yellow fever in all such places is the non-immune immigrant, usually a European;

among the latter, the mortality from the disease is high—the disease in them also usually presenting marked characteristics—its cardinal symptoms. The natives of these places may not unreasonably be described as saturated with yellow fever.

In the British West African Colonies there is a continually increasing immigration of non-immune Europeans—who, until recently, did not live segregated from the native communities. Yellow fever did undoubtedly occur among these Europeans, but never to the same extent as in those places in the New World where one could fairly confidently describe the native as being saturated with yellow fever.

It has been supposed that Europeans in West Africa gained a partial immunity to yellow fever, from many small infections with the virus; that this immunity was lost when on leave in England; and that on returning to the Coast, the European might yet fall a victim to an unusually large dose of the virus before immunity was regained by many small doses. This may be quite true, but there are at present no data to support it.

In any area where, though the adult native population escaped the disease, the children and non-immune immigrant suffered from it, one could safely conclude that a reservoir of the virus was formed by the children mainly, and to a less extent by the non-immune immigrant. There can be no doubt on this point; for direct experiment has shown that *Stegomyia fasciata* can convey the virus from one human being to another. Human beings, therefore, may form a reservoir of yellow fever.

No exact data exist, however, showing to what extent, in nature, the human reservoir, child and adult, is operative in keeping up the endemicity of the disease; while there are instances of places —long before the days of anti-mosquito brigades—notoriously the haunt of yellow fever, suddenly entering on a period, sometimes a generation, of freedom from this disease, in spite of the continual influx during this period of non-immune Europeans, not living apart from the natives of the place, and forming in themselves the most certain indicator of the presence of yellow fever, did it exist.

All investigations of this phenomenon in the epidemiology of yellow fever have so far failed to provide any explanation on the theory that the main reservoir of the disease is to be found in

children or indeed in adults. Nor has any evidence worth considering been brought forward that in such places, during the period of disappearance of the disease, *Stegomyia fasciata* was any less common than formerly. After a longer or shorter period these places have again been the field of epidemic outbreaks.

The experiments of Marchoux and Simond appeared at first to establish the fact of the hereditary transmission of the virus in *Stegomyia fasciata*. There is a possibility, however, of the infection of their patient from sources outside their control. This point, therefore, remains to be settled definitely.

The average percentage of mosquitoes becoming infected after feeding on a human being suffering from yellow fever is quite unknown; though it has been shown that one infected *Stegomyia fasciata* may convey the disease to man; and it is plain that the larger the number of mosquitoes, the greater the chance of infection of x numbers of them.

The chance of infection of *Stegomyia fasciata* from human beings must also be in direct ratio to the time during which the virus is present in the blood of the latter. The findings of the American Commission in Havana, on this point, have recently been criticized and objected to by Seidelin; and it may be that now on this matter no certain pronouncement can safely be made.

It is known that under laboratory conditions an infected *Stegomyia fasciata* can live for thirty days and retain its infection. How far true this may be in nature is not known.

No exact observations exist on the meteorological factors influencing the infection of the mosquito with the virus; though it is well known that cold weather puts an end to an epidemic.

Lastly, there is the question of the virus being present in lower animals. Direct experiments by Thomas and Seidelin have shown that the virus can be transmitted to the anthropoid ape, and to guinea-pigs, from human beings.

Does the disease exist in nature in lower animals living in more or less close relation to man: and is this the real reservoir of the disease?

Manson first put forward this view. It would explain many apparent puzzles about the endemicity of the disease. There are many similarities in the epidemiology of yellow fever with that of

plague; though yellow fever is not peculiar in this respect. Nothing is at present known of an animal reservoir for yellow fever. It is only just now being looked for.

When one comes to consider the clinical phenomena of the disease as a means to its discovery, again difficulties are met with. Well marked cases, occurring repeatedly, with all the cardinal symptoms, perhaps present no difficulty. Nearly all writers on the subject, however, agree that one, or more, or all these cardinal symptoms may be absent. One is tempted to wonder how in the last case the diagnosis of yellow fever is so surely arrived at.

Even admitting that it cannot be denied that in yellow fever, as in other diseases where we are on the sure ground of knowing and finding the parasite, human beings may be infected and yet show little or none of the symptoms of the disease—even also remembering that by direct experiment an illness was given to a human being which though very mild and '*atypical*,' was still yellow fever—yet there are, even in yellow fever countries, mild and 'atypical' fevers which are not yellow fever—they may, for example, be malaria.

The investigator is faced with the difficulty, perhaps, of classifying these mild fevers. It cannot be done on purely clinical findings.

There is some general agreement that the cardinal symptoms of yellow fever are icterus, albuminuria and slowing of the pulse rate.

Short of demonstrating the parasite, blood examinations by the microscope can aid in the differential diagnosis by at any rate excluding malaria definitely. Seidelin, and others, have shown that in yellow fever there is present a slight leucopenia with a relative increase of large mononuclear leucocytes.

Up to the time of writing, Seidelin's *Paraplasma flavigenum* has not gained universal acceptance as the parasite of yellow fever.

The certain ease with which, by destroying *Stegomyia fasciata*, yellow fever is banished, makes its investigation all the harder. One must have yellow fever cases in order to study yellow fever. It is spoken of as a disappearing disease in the Americas. It appears to be an elusive one in Africa.

In Sekondi, observation of fevers in adult natives is not difficult—with children, however, it is very difficult. The bar of

language alone is serious. Very few children are brought to the native hospital, and it is very rare for one of them to be left there for treatment. Mild cases of illness in the children appear to pass unnoticed by the mothers. Instances of this, where the children were ill with fever and infected with malaria parasites, have been observed by me. But nine children who were actually ill have been seen by me in these seven months, though many were examined at different times. Of these nine, three were suffering from lung complaints and six from malaria. It might, therefore, be propounded that since yellow fever was present in epidemic form in Sekondi in 1910, it was probably still present, at any rate among the native children—for all that any actual observation of illness among these children could show to the contrary. For reasons given below, that is almost certainly not the case. It has been stated—among the many other speculations about it based on scanty data—that for yellow fever, contrary to what obtains for malaria, there is found a small reservoir of the virus and a large volume of *Stegomyia fasciata*. The reservoir must first be known before its size can be defined.

As to the volume of *Stegomyia fasciata*, one is here on surer ground. All observations in yellow fever places agree on the large numbers of these mosquitoes in and around human dwellings; and all experience so far has found the rapid disappearance of the disease following on the carrying out of adequate measures for reducing the numbers of this mosquito. The disease disappears before all the mosquitoes do.

In Sekondi, a year's continual observation has shown that mosquitoes are very rare, not alone in European bungalows, but among the native houses. Anti-mosquito measures are continually enforced by the Sanitary Department. During the year 1913, 57,064 inspections of premises were carried out and larvae were found 342 times. These inspections were from time to time checked by inspections carried out by the Medical Officer of Health in person, and by the two European Sanitary Inspectors. The numbers are, therefore, fairly reliable. They give a larval ratio of ·0005. It is difficult to imagine, under such conditions, how yellow fever can be endemic in Sekondi.

All larvae found were, by order of the Medical Officer of Health, submitted to the Commission for examination.

During the seven months, 206 lots of larvae were brought for examination. In only seven cases the samples contained pupae. The age of the larvae in the other lots varied, but most of them were young.

Seventy per cent. of all larvae were those of *Stegomyia fasciata*. The other larvae belonged to other culicine species, *Culex duttoni* and *Culex tigripes* being common.

No *Anopheles* larvae were found. It is curious that *Culex fatigans* was never found. The larvae were all taken from various receptacles in and around human dwellings.

It was noticed that during the dry months—January to April—all the lots of larvae sent up for examination contained only those of *Stegomyia fasciata*.

Manson has suggested that the parasite of yellow fever, although said to be invisible in the blood of human beings suffering from the disease, might yet be demonstrable in the salivary glands and alimentary canal of *Stegomyia fasciata* fed on such patients.

It was thought, therefore, to be of some interest and value, as controls, to determine the usual fauna and flora of the alimentary canal and the condition of the salivary glands of female *Stegomyia fasciata* which had not fed on blood infected with yellow fever.

The mosquitoes were dissected in sterile physiological salt solution. The salivary glands and alimentary canal when removed were promptly transferred to a new slide and washed in fresh sterile physiological salt solution. This was repeated a third time, and then alimentary canal and salivary glands were transferred to a clean dry slide. They were then dissected with fine needles, fixed in absolute alcohol and stained with Giemsa.

All specimens of alimentary canal were rejected unless removed intact; and in the case of the salivary glands unless one lobe, at least, was undamaged.

Out of many adult female *Stegomyia fasciata* dissected, forty-seven specimens answering this condition were obtained. Of these forty-seven, thirty-nine were from female *Stegomyia fasciata* one to eight hours after the imago had emerged from the pupa. They were bred out from different lots of larvae from various parts of Sekondi, collected during December, January and March. The imagines had not fed.

Alimentary Canal. In twenty, micro-organisms were found in

the gut and malpighian tubes. Of these twenty, three contained *Herpetomonas*-like flagellates with double flagellum—probably dividing forms. One contained a large faintly stained *Spirochaeta* about the size of *Sp. refringens*. Seven contained yeasts. Fifteen contained bacteria, cocci and bacilli. Three contained gregarines. In two of them the free forms were seen in the gut, and in all developing stages were found in the malpighian tubes. In the remaining nineteen, no micro-organisms were discovered. Eight adult female *Stegomyia fasciata* were caught in native quarters. Presumably these mosquitoes had already fed on human blood. In the alimentary canal were found:—

Bacteria—bacilli and cocci—in all.
In five, yeasts.
In three, *Herpetomonas*-like flagellates, with double flagellum.

In all the forty-seven, no micro-organisms were found in the salivary glands; nor was there noted any difference between the salivary glands from the mosquitoes bred out in the laboratory and those caught in houses.

It was intended, had material been available, to carry out inoculation experiments on guinea-pigs with the virus of yellow fever. Lack of material made this impossible. Certain observations on guinea-pigs were, however, made. Their interest lies solely in that they may serve as controls for the inoculation experiments of others.

Temperature of Normal Guinea-pigs. The temperatures of seven healthy adult female guinea-pigs were taken night and morning for two periods of thirty days each, with three weeks intervening between each period. The temperatures were all taken per rectum between 7.30 and 8 a.m. and 6.30 and 7 p.m.

The temperature varied—102° F. and 103° F. were noted at times. The lowest temperature noted was 99.

The average temperatures (Fahrenheit) for the two periods of thirty days for the seven guinea-pigs were:—

	Morning	Evening
Room temperature	81·7°	85·2°
Guinea-pig 1	100·1°	100·2°
,, 2	100·1°	100·2°
,, 3	100·3°	100·4°
,, 4	100·1°	100·7°
,, 5	99·9°	100°
,, 6	100·2°	100·5°
,, 7	100·1°	100·3°

The normal temperature of the healthy guinea-pig here may be taken then as 100° F.

These seven female guinea-pigs were during the two periods of thirty days each, mentioned above, catheterised every third day. It was found easy to do this, and to obtain sufficient urine for analysis. The urine was always filtered before analysis. In no instance was albuminuria detected.

Guinea-pig 1 was inoculated intraperitoneally with 0·1 c.c. of citrated (1 per cent.) blood from a native youth suffering from malarial fever. The blood contained large numbers of young subtertian rings.

Guinea pig 2 was inoculated with 0·5 c.c. of this blood.

Guinea-pig 3 with 1 c.c. of this blood.

Guinea-pigs 4, 5 and 6, respectively, with 0·1 c.c., 0·5 c.c. and 1 c.c. of normal human blood in 1 per cent. sodium citrate solution. The inoculations were all intraperitoneal.

The inoculations appeared to have no effect on the animals. The usual temperatures were noted. Daily catheterisation did not reveal any albuminuria. No changes were noted in the blood, examined daily, nor were any unusual bodies worthy of special notice found. One hour's examination of each film was made. The guinea-pigs remain alive and well at the time of writing.

Of the fourteen guinea-pigs obtained towards the end of December, four young and one adult died. Post-mortem examination showed nothing abnormal. No evidence of gastritis—no haemorrhages—no albuminuria. In no case were bodies with the definiteness shown in the published drawings of *Paraplasma flavigenum* seen. Small indefinite grey-blue bodies and red stained *Anaplasma*-like dots in the red cells were seen occasionally. It would perhaps not be fair to call these *Paraplasma*-like bodies without actual comparison with Seidelin's *P. flavigenum.*

A special search was made in various blood films for bodies resembling *Paraplasma flavigenum* (Seidelin).

The films were spread thinly, fixed in equal parts of absolute alcohol and ether, dried and stained with Giemsa. Deep nuclear staining was always aimed at. The films were washed in rain-water, dried, and then examined by the 1/12th oil immersion lens and No. 3 ocular.

One hour's examination was given to each film.

The following blood-films were thus searched for *Paraplasma*-like bodies:—

From 5 normal human beings.
3 cases of malarial fever.
1 case of gonorrhoeal rheumatism with fever.
2 cases of amoebic dysentery with fever.
1 case of streptococcal septicaemia.
22 rats caught in various parts of the town.
2 mice.
2 monkeys.
4 European dogs.
13 Pariah dogs.
7 cats.
and 35 films from 12 guinea-pigs.

In many of these films, as, indeed, in other films, bodies more or less resembling *Paraplasma flavigenum* as figured by Seidelin were often seen: blood films here being, in this, no exception to blood films in England. But they all lacked definiteness and constancy of outline and staining property. Anyone accustomed to examine blood films must have seen them many times. Their very variability makes them indescribable. Careful examination, however, of these bodies always seemed to make it plain that they were artefacts, small particles of débris, stain deposits, minute cracks in the erythrocytes or structural irregularities of the cell, perhaps of developmental origin.

It is said that *P. flavigenum* can, as a rule, only be differentiated accurately from artefacts, etc., by using an apochromatic oil immersion lens with a compensating eye-piece. This apparatus was not available, however.

Among the twenty-two rats' blood examined, twenty were found infected with *Trypanosoma lewisi*, and two with a rather small *Spirochaeta*. No other of the above animals' blood contained any parasites.

The blood of yet other animals was examined periodically, at the request of the Sanitary Department; no special search, however, being made for *Paraplasma*-like bodies.

56 Oxen ... 23 were infected with *Trypanosoma*.
7 with *Babesia*—probably *mutans*, sp.
2 with *Trypanosoma* and *Babesia*.

In the *Trypanosoma-* and *Babesia*-infected ox's blood, erythrocytes with large, some round, some elongated, deeply basophilic granules were frequently noted.

36 Sheep	...	1 infected with *Trypanosoma.*
		1 infected with *Spirochaeta.*
91 Goats	...	5 infected with *Trypanosoma.*
		3 with *Spirochaeta.*
21 Pigs	...	No parasites found.

Owing to the methods at present adopted, of necessity, in the slaughter-house, it was not possible to collect any intestinal parasites.

Fasciola angusta was often found in the livers of the oxen.

Twenty-three post-mortem examinations of human beings were carried out by me.

The rest of our work consisted in the examination of blood and other pathological material from cases in, and attending, the European and native hospitals in Sekondi, and occasionally from Tarquah, Inchaban Water Works, and Abosso. Material was also sent from Tamale by Dr. Clough for examination, and other material brought down from Northern Territories by Dr. Coghill and examined here.

Serum from two cases, one European, one native, was sent by Dr. W. J. Bruce from Abosso, with details of the cases. The serum in both cases agglutinated *Micrococcus melitensis* in dilutions of 1-80—complete in three hours.

No clumping was obtained with control bacteria, e.g., *B. typhosus* and *B. paratyphosus.* With normal control serum the bouillon culture of *M. melitensis* gave partial clumping up to 1-20 dilution only.

With the exception of two cases, in all blood films examined a differential leucocyte count was done, and a thick film preparation examined as well.

Malaria parasites were usually not found in fifteen minutes' examination of the thin blood film.

In many cases, however, they were readily found in the thick film. This happened with the very great majority of cases in which malaria parasites were found at all.

The average large mononuclear leucocyte count is higher than in England, as has been noted by others.

Here, the average for cases in which no malaria parasites could be found in the thick film preparation is between 9 and 11 per cent.

In all cases where the large mononuclear leucocyte count was 13 per cent. and over, malaria parasites could be demonstrated.

Thirty-two 'total' erythrocyte and leucocyte counts were done.

Four hundred and sixty-four blood films were examined and differential counts done.

Four hundred and sixty-two thick blood films were examined as well: from 135 Europeans and 327 natives.

These all came from Sekondi, and were from cases under medical treatment or seeking medical advice.

Malaria parasites were found in	144 Natives. 67 Europeans.
Subtertian parasites were found in	107 Natives. 61 Europeans.
Quartan parasites were found in	24 Natives. 9 Europeans.
Benign tertian parasites were found in ...	17 Natives. 4 Europeans.
Quartan and benign tertian together in ...	1 Native. 1 European.
Quartan and subtertian together in	2 Natives. 3 Europeans.
Subtertian and benign tertian together in ...	1 Native. 3 Europeans.

Gametocytes were very seldom found, and when found were always very scanty.

They were present in the blood of	14 Natives. 9 Europeans.
Benign tertian gametocytes were found in ...	2 Natives.
Quartan gametocytes were found in	3 Natives. 1 European.
Subtertian gametocytes were found in ...	9 Natives. 8 Europeans.

In only five films were pigmented mononuclears noted.

Erythrophagocytosis was frequently observed. With very few exceptions, the blood of the natives examined came from adults.

Filarial embryos were found in the blood of twenty-one natives and one European. It must be noted in this connection that only 'day' blood was examined.

Filaria perstans was found in the blood of ...	1 European and 7 Natives.
Filaria bancrofti was found in the blood of ...	10 Natives.
Filaria loa was found in the blood of	5 Natives.
Filaria loa and *Filaria perstans* were found in the blood of	2 Natives.
Filaria perstans and *Filaria bancrofti* were found in the blood of	3 Natives.

In three films *Trypanosoma* was discovered. All were from natives. The trypanosomes were of the *gambiense* type. The patients had been for more than a year in Sekondi; before that they had been in the Northern Territories.

With the assistance of Dr. G. P. G. Beckett, Medical Officer, an examination was made of the blood of fifty-seven children at Inchaban. Thin and thick films were searched. Malaria parasites were found in thirty-five, i.e., 61 per cent.

Subtertian were found in	26
Quartan were found in	8
Benign tertian were found in	3
Subtertian and quartan together in	2

The parasites were all in the young stages of growth, and were always scanty. But one of the children had fever—in this film scanty quartan rings were found.

Gametocytes were found only in four, i.e., 7 per cent., and in these were very scanty.

Quartan gametocytes in	3
Benign tertian gametocytes in	1

It is curious that no subtertian gametocytes were discovered.

In an examination of the blood of fifty-three school children in Sekondi:—

Malaria parasites—always scanty—were found in 29, i.e., 54 per cent.
Scanty gametocytes were found in 2 only, i.e., 3 per cent.

The reservoir for malaria—its possible endemic strength—is therefore double as great in Inchaban, four miles out of Sekondi, as in Sekondi itself.

It is known that the parasites of malaria may live in the human body for three years, commonly.

Anopheles are extremely rare in Sekondi to-day. It is more than probable that the majority, if not all, of these latter cases were infected one or more years ago.

Two hundred and forty-seven analyses of urine were done; seventy-nine from Europeans and one hundred and sixty-eight from natives.

In three cases—all natives—terminal spined schistosome ova were found.

Twenty-nine sputa were examined; one from a European, twenty-eight from natives.

In nine cases—all natives—tubercle bacilli were found.

Nineteen showed pneumococci.

The faeces of two hundred and nine cases (thirty-two Europeans, one hundred and seventy-seven natives) in the hospitals were examined. Repeated examinations of many of them were made.

No helminthic parasites or their ova were found in Europeans.

In the thirty-two Europeans, there were found *Entamoeba coli* cysts in five. *Entamoeba histolytica* was found in ten. In two of these the four-nuclear cysts were found.

In one of the cases of *Ent. histolytica* infection, *Trichomonas intestinalis* was found and also *Balantidium minutum*. This was a somewhat obstinate case of dysentery, reacting but slowly to emetine.

In the faeces of the one hundred and seventy-seven natives there were found:—

Entamoeba coli cysts in ...	22	
Entamoeba histolytica in ...	8	3 with the 4-nuclear cysts.
Trichomonas intestinalis in ...	15	
Spirochaeta in	5	
Balantidium minutum in ...	1	This was a case of dysentery. It reacted to emetine.

In seven cases, blood and leucocytes were found in the faeces—the clinical phenomena were those of acute dysentery, but repeated examinations did not reveal any protozoal parasites.

In three cases, the embryos of *Strongyloides stercoralis* were found.

One hundred and one contained ova of helminths.

Terminal-spined *Schistosoma* ova in	2
Ankylostome ova in...	55
Ascaris ova in	53
Trichiuris trichiura ova in	29
Taenia ova in	5

In three of the cases where *Taenia* ova were found proglottides were obtained. They belonged to *T. saginata*.

Ascaris and ankylostome ova together in	18
Ascaris and *Trichiuris* ova together in	12
Ankylostome and *Trichiuris* ova together in	11
Ankylostome, *Ascaris* and *Trichiuris* ova together in ...	8

This gives a percentage of thirty infected with ankylostome ova. The infections were always scanty, however, and no case was observed in which the clinical symptoms or the blood picture suggested the anaemia of ankylostomiasis.

These one hundred and seventy-seven were all cases admitted to the native hospital for various ailments—more than half of them for surgical complaints.

As a control, with the assistance of Dr. H. F. Hamilton, during April, 1914, an examination was made of the stools of eighty-six prisoners, all in apparent health, in the Central Gaol. The very great majority of these eighty-six came from districts outside of Sekondi.

Ankylostome ova were found in	27
Ascaris ova were found in	23
Trichiuris trichiura ova were found in	6
Oxyuris vermicularis ova were found in	1
Ankylostome and *Ascaris* ova were found in	16
Ascaris and *Trichiuris* ova were found in	3
Ankylostome and *Trichiuris* ova were found in	3
Ankylostome, *Ascaris* and *Trichiuris* ova were found in	2

This gives an ankylostome infection of 31 per cent. Here, again, the infection was always scanty.

Of the eighty-six prisoners' faeces, thirty-six contained protozoal parasites.

Entamoeba coli cysts in	30 = 35 per cent.
Trichomonas intestinalis in	8
Entamoeba histolytica cysts in (4-nuclear cysts) ...	3
Entamoeba coli and *Trichomonas* in	3

In marked contrast to May, June and July, 1913, no *Glossina* and no *Culicoides* have been seen in Sekondi since November, 1913.

I desire to record my indebtedness, during the course of this work, to the courtesy and assistance of Dr. E. W. Graham, Senior Medical Officer, Dr. A. C. Lorena, Medical Officer of Health, and Drs. J. M. Fraser, H. W. Gush, R. O. White, G. P. G. Beckett, and H. F. Hamilton.

Clinical Notes and Post-Mortem Findings of a Case of Suspected Yellow Fever referred to on Page 703.

Native, male, 19 years old, admitted to native hospital under the care of Dr. H. W. Gush, Medical Officer, October 25th, 1913.

This patient was sent into Sekondi from Inchaban by Dr. G. P. G. Beckett, as a case of suspected yellow fever. The patient's illness began with rigors three days before admission to hospital. Since then, fever and headache, no vomiting. He had not noticed anything unusual with his urine and faeces.

October 25th. Condition on admission to hospital.—Mentally alert. No headache, no photophobia, eyes bright, conjunctivae injected. Sclerae very yellow—very much more so than is found in healthy natives. Tongue, dry heavy yellowish fur all over. Gums very injected, spongy, bleeding readily on pressure. Breath very foul. On further examination, somewhat marked *pyorrhoea alveolaris* both sides, upper and lower jaw, was found.

Thorax.—Heart: apex beat in nipple line in fifth intercostal space, sounds clear, no bruits, rhythm regular.

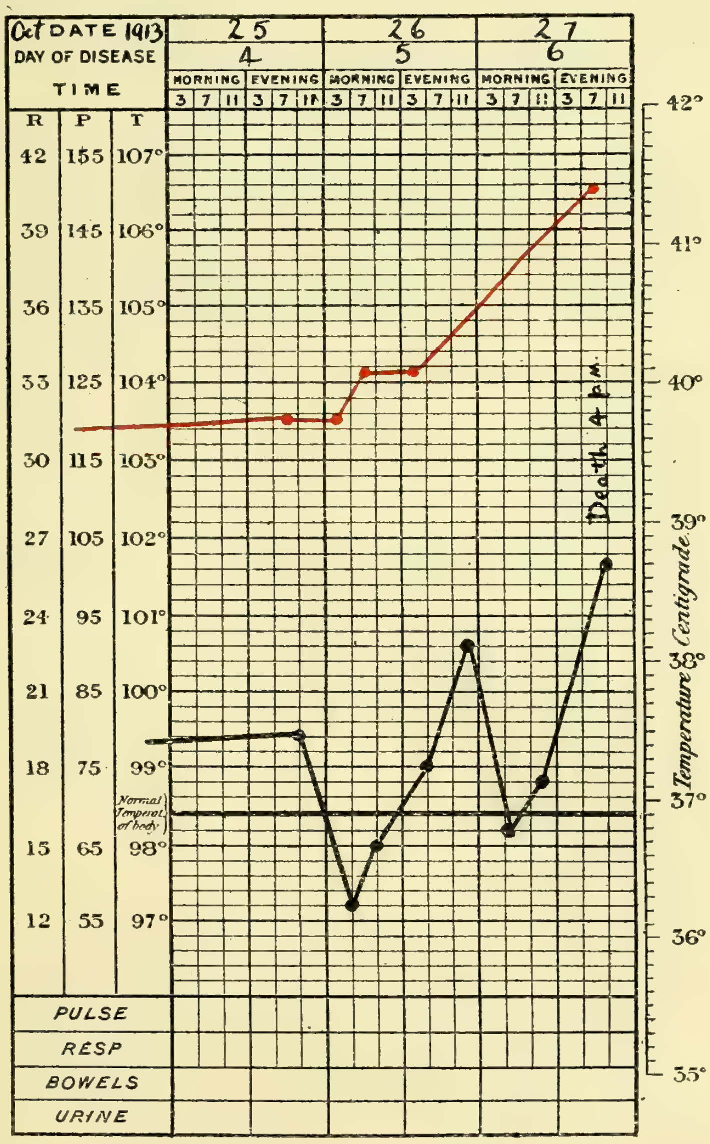

Chart II

Pulse.—120 per minute, regular, pressure low.

Lungs.—Scattered moist râles, both bases. Respirations 22 per minute.

Abdomen.—Marked retraction, very pronounced tenderness over epigastrium and right hypochondrium.

Liver.—Not palpable. By percussion, dullness at sixth rib in nipple line, ceasing at costal margin.

Spleen.—Palpable 2 in. below costal margin, tender.

Legs.—Normal: knee-jerks present and normal.

Finger nails very jaundiced.

No lymphatic enlargement, cervical, axillary, inguinal and femoral regions.

Urine.—Very dark smoky colour with heavy brown deposit—acid. Sp. gr. 1030. Large quantity of albumen and bile pigment present.

By spectroscope.—Distinct oxyhaemoglobin bands present.

By microscope.—Many red blood corpuscles, many leucocytes and epithelial cells, much brown débris (? destroyed red blood cells), no definite casts. Very large number of terminal-spined *Schistosoma* ova.

Blood.—Differential count 1,000 leucocytes:—

Polymorphonuclears...	87 %
Lymphocytes	10 %
Large mononuclears	3 %

Thin and thick film preparations stained by Giemsa carefully searched—no parasites found.

26th.—Physical signs unchanged. Patient very restless. Bleeding from gums began in early morning—bleeding is free. No vomiting.

Stools.—Very clay-coloured.

By microscope.—Scanty terminal-spined *Schistosoma* ova found.

Blood.—Total red corpuscles, 3,800,000 per mm.^{3}; total leucocytes, 36,000 per mm.^{3}

Differential count 1,000 leucocytes:—

Polymorphonuclears...	93 %
Lymphocytes	5 %
Large mononuclears	2 %

Careful search made in thin and thick blood-film preparations—no parasites found.

Urine.—No change.

27th.—Patient very much weaker, very restless, copious bleeding from gums has continued. No vomiting. Pulse very weak and soft, 120 per minute. No bruits over heart. Extremities cold. No change in other physical signs.

Urine and faeces.—No change.

Blood.—Differential count 1,000 leucocytes:—

Polymorphonuclears...	97 %
Lymphocytes	2 %
Large mononuclears	1 %

Total red corpuscles, 3,120,000 per mm.^{3}; total leucocytes, 92,000 per mm.^{3} No parasites found. Patient died at 4 p.m. One hour before death 10 c.c. of blood withdrawn from right median basilic vein, with aseptic precautions, and tubes of sterile broth inoculated. Clotting of the blood was much delayed.

Autopsy.—5 p.m., October 27th.

Most of the teeth loose. Marked *pyorrhoea alveolaris.*

After opening thorax aseptic puncture of right ventricle and 15 c.c. of blood withdrawn by sterile pipette and inoculated into tubes of sterile broth. All the tissues were decidedly yellow.

Pericardium.—Normal, no excess of fluid in sac.

Heart.—8½ ozs., very yellow. Right side somewhat dilated. Nothing else abnormal.

Lungs.—Venous congestion of bases, nothing else abnormal.

Abdomen.—

Liver.—2 lbs. 4 ozs., extremely yellow and friable, very marked fatty degeneration on section. Gall bladder empty. Dense stout adhesions all round gall bladder and bile duct. No constriction of, nor pressure on, common bile duct by adhesions could be demonstrated.

Spleen.—18 ozs., very congested, dripping; deep red colour on section.

Kidneys.—Rather pale. Nothing else abnormal to naked eye. Left kidney 6 ozs., right kidney 3¾ ozs.

Suprarenals.—Nothing abnormal noticed.

Pancreas.—Apparently normal.

Oesophagus—stomach, duodenum, small intestine.—No sub-mucous haemorrhages, no black grumous material in lumen, nothing abnormal found. Clay-coloured faeces in large intestine and rectum.

Bladder.—Mucous membrane covered, more especially at trigone, with many small petechiae.

Brain and meninges.—Nothing abnormal found.

Sections of the liver showed intense fatty degeneration, no intact liver cells being seen, and the demarcation of the lobules being entirely lost. Sections of the kidneys showed infiltration with small round cells: most marked around the glomeruli, cloudy swelling and breaking up of the cells lining the tubules. Sections of stomach and duodenum showed nothing abnormal. Sections of the bladder showed this tissue packed with *Schistosoma* ova.

From the blood taken before death, and from that taken at the autopsy, a pure growth of short-chained streptococci was obtained. 2 c.c. of a 48 hours' bouillon culture of this streptococcus was inoculated intraperitoneally into two wild rats. One rat died in three days, the other in four days. In both, post-mortem, petechiae and sub-mucous haemorrhages were found in stomach, intestines, and pericardium. The spleen in both cases was much enlarged. The urine found in the bladder of the second rat contained albumen. From the spleen of both, a pure growth of short-chained streptococcus was obtained.

H. M. H.

RESULTS OF EXAMINATION OF BLOOD, FAECES, AND URINE FROM 100 APPARENTLY HEALTHY PRISONERS IN THE ACCRA JAIL, GOLD COAST.

In the accompanying tables the prisoners who were found to harbour parasites have been classified by the locality in which they resided, prior to their imprisonment. Where this was not possible, the name of the country or tribe to which they belonged has been given instead. In the column adjacent to the names the numbers of each tribe, etc., have been set forth, and the remaining columns give the total parasites against each.

On the following page the percentages are given. In many cases these are of little value, owing to the fact that, on several occasions, the total number of prisoners did not exceed one. The remaining pages contain the full details of all the prisoners examined, both infected and non-infected.

It was found that no statistics could be deduced from the length of imprisonment of each individual. The difference between those who had served two or three weeks and those who had served one year, or more, was not apparent.

It would seem that each prisoner was infected before his sentence was passed, and that it did not originate in the jail.

On more occasions than not, two or three preparations of faeces had to be made, and examined, before the presence of intestinal parasites could be detected, the infections, with few exceptions, being very small.

In comparing the healthy prisoners of Accra with those of Sekondi, intestinal parasites do not seem to vary much either in numbers or variety between the two. *Schistosoma* was not found in Sekondi among the prisoners, whereas in Accra 6 per cent. of cases were found, 5 per cent. intestinal and 1 per cent. in the urine.

Definite conclusions cannot be arrived at with regard to parasites inhabiting the blood, owing to the fact that those examined in Sekondi were taken in the middle of the rainy season last year, whereas the Accra ones were examined between the 11th March and 29th April, 1914, that is before the rainy season had set in. Quartan malaria, however, would seem to be more prevalent in Sekondi, as no evidence of this parasite was observed

in Accra. Parasites carried by mosquitoes, such as the malaria parasites and *Filaria bancrofti*, are more numerous in Sekondi. Doubtless the season of the year was greatly to blame, but the close proximity of the jail to the lagoon in Sekondi is no doubt responsible for part of this increase. Other parasites not dependent on seasonal incidence showed little variation between the two.

The following details have been compiled after an examination of the blood (thick and thin films), of faeces and urine of apparently healthy prisoners in the Accra jail between the 11th March and the 29th April, 1914:—

Total number of prisoners examined	100
Total number of prisoners harbouring parasites	62

Blood examination

Total number in whom malaria parasites were found	8 %
Of these subtertian parasites numbered	6 %
And benign tertian parasites numbered	2 %

No quartan parasites were found. Only three out of the total could be found in thin films.

Total number of *Filaria* embryos in the blood	13 %
Of these *Filaria perstans* alone numbered	10 %
Filaria diurna alone numbered	2 %
Filaria nocturna alone numbered	2 %
Filaria nocturna and *Filaria perstans* together	1 %

No other parasites were found in the films.

Faeces

Total number with ova in faeces			56 %
Of these ankylostomes numbered	23 %	of which 13 % contained them only	
Ascaris numbered	30 %	,, 20 % ,,	
Trichiuris trichiura numbered ...	14 %	,, 6 % ,,	
Taenia saginata numbered ...	1 %	No others present	
Strongyloides stercoralis numbered...	1 %	,, ,,	
Strongyloides stercoralis and *Trichiuris* together numbered ...			1 %
Ankylostomes and *Ascaris* together numbered			5 %
Ascaris and *Trichiuris* together numbered			4 %
Trichiuris and ankylostomes together numbered			3 %
Trichiuris, *Ascaris*, and *Schistosoma* together numbered			1 %

Locality, etc.

Locality or name of tribe	Total number of each tribe, etc., infected	Ankylostomes	*Ascaris*	*Trichiuris trichiura*	*Strongyloides*	*Schistosoma* ova	*Filaria loa*	*Filaria bancrofti*	*Filaria perstans*	*Taenia saginata*	*Trichomonas intestinalis*	*Entamoeba bist.* (*tetragena*)	*Entamoeba coli*	Benign tertian malaria	Subtertian malaria
Hausa	3	1	3	...	...	...	...	1	3	...	1	1	1	...	...
Nsawam	2	...	1	1	...	...	1	...	...	...	...	...	...	...	...
Popo	1	1	...	...	...	...	...	...	...	...	...	...	...	...	1
Accra	7	3	3	1	...	1	...	...	1	...	1	...	5	1	...
Grunshi	1	...	...	...	...	...	...	...	...	1	...	...	...	...	...
Saltpond	1	...	1	1	...	...	...	...	...	...	...	...	...	...	...
Akim	3	1	3	2	...	...	...	...	...	...	...	...	2	...	1
Axim	1	...	1	...	...	...	...	...	...	...	...	...	...	...	...
Kroo	10	7	6	4	1	2	...	1	1	...	3	2	8	...	1
Quittah	1	...	...	...	...	...	...	...	1	...	...	...	...	...	...
Osokore	1	...	1	...	...	...	...	...	...	...	...	...	...	...	...
Mampong	2	1	1	...	...	...	...	...	...	...	...	...	1	...	...
Addah	3	1	...	1	...	1	...	...	...	...	...	...	1	...	1
Akropong	1	...	1	...	...	...	...	...	...	...	...	...	...	...	...
Kibbi	2	1	1	...	...	...	...	...	...	...	...	...	...	...	...
Abumso	1	...	...	1	1	...	...	...	...	...	...	1	...	...	...
Awuna	9	4	2	1	...	...	...	...	3	...	1	...	7	...	...
Mendi	3	1	1	1	...	...	1	...	...	...	1	...	...	...	...
Timini	2	...	...	1	...	1	...	...	1	...	...	...	...	...	...
Fanti	1	...	1	...	...	1	...	...	...	...	...	...	...	...	...
Kripe	2	1	2	...	...	...	...	...	...	...	...	...	...	...	...
Togoland	1	1	...	...	...	...	...	...	...	...	...	...	...	...	...
Lagos	1	...	1	...	...	...	...	...	...	...	...	...	...	...	1
Unknown	3	...	1	...	...	...	...	...	...	...	...	...	1	1	1
	62 %	23 %	30 %	14 %	2 %	6 %	2 %	2 %	10 %	1 %	7 %	4 %	26 %	2 %	6 %

THE PERCENTAGE OF EACH TRIBE FOUND TO HARBOUR PARASITES.

Tribe	Ankylostomes	*Ascaris*	*Trichiuris trichiura*	*Strongyloides*	*Schistosoma*	*Filaria loa*	*Filaria bancrofti*	*Filaria perstans*	*Taenia saginata*	*Trichomonas intestinalis*	*Entamoeba tetragena*	*Entamoeba coli*	Benign tertian	Quartan	Subtertian
Kroo	70·0	60·0	40·0	10·0	20·0	...	10·0	10·0	...	30·0	20·0	80·0	...	...	10·0
Awuna	44·4	22·2	11·1	...	...	...	...	33·3	...	11·1	...	77·7	...	...	...
Hausa	33·1	100·0	...	...	...	...	33·3	100·0	...	33·3	33·3	33·3	...	...	...
Nsawam	...	50·0	50·0	...	...	50·0	...	...	...	...	...	...	...	...	...
Popo	100·0	...	...	...	...	...	...	...	...	...	...	...	...	...	100·0
Accra	42·8	42·8	14·2	...	14·2	...	...	14·2	...	14·2	...	71·4	14·2	...	...
Grunshi	...	...	...	...	...	...	...	...	100·0	...	...	...	...	...	...
Saltpond	...	100·0	100·0	...	...	...	...	...	...	...	...	...	...	...	...
Akim	33·3	100·0	66·6	...	...	...	...	...	...	...	...	66·6	...	...	...
Axim	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Quittah	...	...	...	...	...	...	...	100·0	...	...	...	...	...	...	...
Osokore	...	100·0	...	...	...	...	...	...	...	...	...	...	...	...	...
Mampong	50·0	50·0	...	...	...	...	...	...	...	...	...	50·0	...	...	...
Addah	33·3	...	33·3	...	33·3	...	...	...	...	...	...	33·3	...	...	33·3
Akropong	...	100·0	...	...	...	...	...	...	...	...	...	...	...	...	...
Kibbi	50·0	50·0	...	...	...	...	...	...	...	...	...	...	...	...	...
Abumso	...	...	100·0	100·0	...	...	...	...	...	100·0	100·0	...	...	...	...
Mendi	33·3	33·3	33·3	...	...	33·3	...	...	...	...	...	...	33·3	...	...
Timini	...	...	50·0	...	50·0	...	...	50·0	...	...	...	...	...	...	...
Fanti	...	50·0	...	...	50·0	...	...	...	...	...	...	...	...	...	...
Kripe	50·0	100·0	...	...	...	...	...	...	...	...	...	...	...	...	...
Togoland	100·0	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Lagos	...	100·0	...	...	...	...	...	...	...	...	...	...	...	...	100·0
Unknown	...	33·3	...	...	...	...	...	...	...	33·3	...	...	33·3	...	33·3

Serial No. of those examined	URINE: Albumen	URINE: Bile	URINE: Sugar	URINE: *Schistosoma* ova	BLOOD: Differential Count per cent.: Polymorpho-nuclears	Lymphocytes	Large Mononuclears	Eosinophils	Transitionals	Nucleated reds	BLOOD: Malaria Parasites: Benign tertian	Subtertian	BLOOD: *Filaria*: *perstans*	*loa*	*bancrofti*	FAECES: Ankylostomes	*Ascaris lumbricoides*	*Trich. trichiura*	*Strongyloides*	*Schistosoma* ova	*Entamoeba coli*	*Entamoeba histolytica*	*Trichomonas intestinalis*
1	—	—	—	—	24·0	62·0	10·0	4·0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2	+	—	—	—	60·0	20·0	6·0	13·3	0·6	—	—	—	—	—	—	—	—	—	—	—	—	—	—
3	+	—	—	+	36·0	34·0	7·0	22·0	1·0	—	—	—	—	—	—	—	—	—	—	—	—	—	—
4	—	—	—	—	32·6	52·6	8·6	6·0	—	—	—	—	—	—	—	—	—	—	—	—	+	—	—
5	—	—	—	—	26·0	44·0	8·0	21·3	0·6	—	—	—	—	—	—	—	+	+	—	—	—	—	—
6	+	—	—	+	10·6	41·3	4·0	43·3	0·6	—	—	—	—	—	—	—	—	—	—	—	—	—	—
7	—	—	—	—	24·0	16·0	8·5	49·7	1·7	—	—	—	—	+	—	—	+	+	—	—	+	—	—
8	—	—	—	—	34·0	36·0	11·0	14·0	5·0	—	—	—	—	—	—	—	+	—	—	—	—	—	—
9	—	—	—	—	33·0	33·0	14·0	20·0	—	—	—	—	—	—	—	—	+	—	—	—	+	—	—
10	—	—	—	—	47·3	34·0	7·3	8·0	3·3	—	—	—	—	—	—	—	—	—	—	—	—	—	—
11	—	—	—	—	39·0	33·0	14·0	11·0	3·0	—	+	—	—	—	—	—	—	—	—	—	+	+	—
12	+	+	—	—	29·3	28·0	8·0	34·0	0·6	—	—	—	—	—	—	+	—	—	—	—	—	—	+
13	—	—	—	—	30·0	37·3	8·0	20·6	4·0	—	—	—	—	—	—	—	—	—	—	—	—	—	—
14	+	—	—	—	53·3	25·3	8·6	7·0	5·3	—	—	—	—	—	—	—	—	—	—	—	—	—	—
15	—	—	—	—	43·3	36·6	6·6	8·3	0·5	—	—	—	—	—	—	—	—	—	—	—	+	—	—
16	—	—	—	—	33·5	46·0	9·5	9·0	1·6	—	—	—	—	—	—	—	—	—	—	—	+	+	+
17	+	+	—	—	55·3	28·6	4·6	9·3	2·0	—	—	—	—	—	—	—	—	—	—	—	—	—	—
18	—	—	—	—	27·4	45·2	6·0	18·5	3·0	—	—	—	—	—	—	—	—	—	—	—	—	—	—
19	—	—	—	—	51·6	34·6	6·0	6·3	1·3	—	—	—	—	—	—	—	—	—	—	—	—	—	—
20	—	—	—	—	58·0	16·0	7·0	14·0	5·0	—	—	—	—	—	—	—	—	—	—	—	—	—	—
21	—	—	—	—	34·0	52·0	8·0	4·0	2·0	—	—	—	—	—	—	—	—	—	—	—	—	—	—
22	+	—	—	—	49·4	27·3	11·7	10·4	1·3	—	—	—	—	—	—	—	+	—	—	—	+	—	—
23	+	—	—	+	12·6	58·6	10·6	18·0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
24	—	—	—	—	48·6	31·3	7·3	12·6	—	—	—	—	—	—	—	+	—	—	—	—	—	—	—
25	+	—	—	—	24·0	50·0	15·6	10·3	—	—	—	+	—	—	—	+	+	—	—	—	+	—	—
26	+	—	—	—	32·2	39·3	10·3	18·1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Serial No. of those examined	URINE: Albumen	URINE: Bile	URINE: Sugar	URINE: *Schistosoma* ova	BLOOD: Differential Count per cent.: Polymorpho-nuclears	BLOOD: Differential Count per cent.: Lymphocytes	BLOOD: Differential Count per cent.: Large Mononuclears	BLOOD: Differential Count per cent.: Eosinophils	BLOOD: Differential Count per cent.: Transitionals	BLOOD: Differential Count per cent.: Nucleated reds	BLOOD: Malaria Parasites: Benign tertian	BLOOD: Malaria Parasites: Subtertian	BLOOD: *Filaria*: *perstans*	BLOOD: *Filaria*: *loa*	BLOOD: *Filaria*: *bancrofti*	FAECES: Ankylostomes	FAECES: *Ascaris lumbricoides*	FAECES: *Trich. trichiura*	FAECES: *Strongyloides*	FAECES: *Schistosoma* ova	FAECES: *Entamoeba coli*	FAECES: *Entamoeba histolytica*	FAECES: *Trichomonas intestinalis*
27	—	—	—	—	34·6	42·6	7·3	16·6	2·3	—	—	—	—	—	—	—	+	—	—	—	+	—	—
28	—	—	—	—	35·8	36·8	10·8	13·6	2·8	—	—	—	—	—	—	—	—	—	—	—	—	—	—
29	—	—	—	—	34·3	34·6	10·0	16·0	4·0	—	—	—	—	—	—	—	+	—	—	—	—	—	—
30	—	—	—	—	40·3	33·6	6·0	20·0	0·6	—	—	—	—	—	—	—	—	—	—	—	—	—	—
31	—	—	—	—	39·3	47·3	4·0	8·6	0·6	—	—	—	—	—	—	—	—	—	—	—	—	+	+
32	—	—	—	—	51·8	30·8	13·0	2·4	1·8	—	—	—	—	—	—	+	—	—	—	—	+	—	—
33	—	—	—	—	28·6	43·0	9·5	12·4	6·6	—	—	—	—	—	—	—	—	—	+	—	—	—	—
34	—	—	—	—	48·0	30·6	8·0	12·0	0·6	—	—	—	—	—	—	—	+	—	—	—	—	—	—
35	—	—	—	—	29·7	27·1	7·8	31·0	4·5	—	—	—	—	—	—	+	+	—	—	—	+	—	—
36	—	—	—	—	43·3	37·3	8·0	6·0	5·3	—	—	—	—	—	—	—	—	—	—	—	—	—	—
37	—	+	—	—	58·0	32·0	6·6	2·6	0·6	—	—	—	—	—	—	—	—	—	—	—	—	—	—
38	—	—	—	—	57·3	23·3	5·3	14·0	—	—	—	—	—	—	—	—	—	—	—	+	+	—	—
39	+	—	—	—	41·7	30·3	8·5	18·8	0·6	—	—	—	—	—	—	+	+	—	—	—	—	—	—
40	—	—	—	—	35·5	25·1	7·1	28·4	3·8	—	—	—	—	—	—	—	—	—	—	—	—	—	+
41	+	—	—	—	31·3	48·6	9·3	8·3	2·0	—	—	—	—	—	—	—	—	—	—	—	—	—	—
42	+	+	—	—	49·6	13·0	8·7	24·8	3·7	—	—	—	—	—	—	+	—	—	—	—	—	—	—
43	—	—	—	—	42·0	28·0	13·3	12·0	4·6	—	—	—	+	—	—	—	—	—	—	—	—	—	—
44	+	—	—	—	46·0	24·0	8·6	21·3	—	—	—	—	—	—	—	+	—	—	—	—	+	—	—
45	+	—	—	—	19·3	21·3	6·6	49·6	3·3	—	—	—	—	—	—	+	—	—	—	—	—	—	—
46	—	—	—	—	31·1	35·4	4·2	18·4	6·2	—	—	—	+	—	—	—	—	+	—	—	—	—	—
47	+	+	—	—	43·3	26·0	7·3	22·0	1·3	—	—	—	—	—	—	—	—	—	—	—	+	—	—
48	—	—	—	—	41·0	30·1	9·8	17·9	1·15	—	—	—	+	—	—	—	—	—	—	—	+	—	—
49	—	—	—	—	46·0	40·6	10·6	2·6	0·6	—	—	—	—	—	—	—	—	—	—	—	—	—	+
50	—	—	—	—	52·6	30·0	6·0	9·3	2·6	—	—	—	—	—	—	—	—	—	—	—	—	+	—
51	+	—	—	—	43·3	16·6	4·0	33·3	2·6	—	—	—	+	—	—	—	+	—	—	—	—	—	—
52	+	—	—	—	48·0	28·0	16·0	6·0	2·0	—	—	—	—	—	—	—	—	+	—	—	+	—	—

Serial No. of those examined	URINE: Albumen	URINE: Bile	URINE: Sugar	URINE: *Schistosoma* ova	BLOOD: Differential Count per cent.: Polymorpho-nuclears	BLOOD: Differential Count per cent.: Lymphocytes	BLOOD: Differential Count per cent.: Large Mononuclears	BLOOD: Differential Count per cent.: Eosinophils	BLOOD: Differential Count per cent.: Transitionals	BLOOD: Differential Count per cent.: Nucleated reds	BLOOD: Malaria Parasites: Benign tertian	BLOOD: Malaria Parasites: Subtertian	BLOOD: *Filaria*: *perstans*	BLOOD: *Filaria*: *loa*	BLOOD: *Filaria*: *bancrofti*	FAECES: Ankylostomes	FAECES: *Ascaris lumbricoides*	FAECES: *Trich. trichiura*	FAECES: *Strongyloides*	FAECES: *Schistosoma* ova	FAECES: *Entamoeba coli*	FAECES: *Entamoeba histolytica*	FAECES: *Trichomonas intestinalis*
53	+	—	—	—	56·0	22·6	9·3	10·3	1·9	—	—	—	—	—	—	—	+	—	—	—	—	—	—
54	—	—	—	—	49·3	32·0	7·3	8·0	3·3	—	—	—	—	—	—	—	+	+	—	—	—	—	—
55	+	—	—	—	48·3	22·6	11·3	15·3	2·0	—	—	—	—	—	—	—	+	—	—	—	—	—	—
56	+	—	—	—	32·4	51·4	9·5	6·6	—	—	—	—	—	—	—	+	+	—	—	—	—	—	—
57	—	—	—	—	30·0	35·3	10·6	19·3	4·6	—	—	—	—	—	—	—	—	—	—	—	+	—	—
58	—	—	—	—	45·3	29·3	10·6	10·6	4·0	—	—	—	+	—	—	—	—	+	—	—	—	—	—
59	+	—	—	—	40·0	34·0	7·3	16·6	2·0	—	—	—	—	—	—	+	—	—	—	—	—	—	—
60	+	—	—	—	42·6	36·0	10·0	10·0	1·3	—	—	—	—	—	—	—	—	—	—	—	—	—	—
61	—	—	—	—	39·1	24·2	14·9	20·5	1·3	—	—	—	—	—	—	—	+	—	—	—	+	—	—
62	—	—	—	—	40·0	34·0	10·0	15·0	1·0	—	—	—	—	—	—	+	—	—	—	—	—	—	—
63	—	—	—	—	42·0	30·6	6·6	20·0	0·6	—	—	—	—	—	—	—	+	—	—	—	—	—	—
64	—	—	—	—	38·0	49·3	8·6	4·0	—	—	—	—	—	—	—	—	—	+	+	—	—	—	—
65	—	—	—	—	46·0	21·3	10·6	20·0	2·0	—	—	—	—	—	—	—	—	—	—	—	+	—	—
66	+	+	—	—	43·8	24·1	5·5	25·3	0·6	0·6	—	—	+	—	—	—	—	—	—	—	—	+	—
67	—	—	—	—	27·3	36·6	14·6	19·3	2·0	—	+	—	—	—	—	+	—	—	—	—	—	—	—
68	—	—	—	—	44·9	20·5	5·7	27·5	1·5	—	—	—	+	—	—	+	—	—	—	—	—	—	—
69	+	—	—	—	35·3	26·0	8·0	30·0	0·6	—	—	—	—	—	—	+	—	—	—	—	—	—	—
70	—	—	—	—	46·6	31·3	6·6	14·6	0·6	—	—	—	+	—	—	—	—	—	—	—	—	—	—
71	—	—	—	—	38·6	46·6	10·0	4·6	—	—	—	+	—	—	—	—	—	—	—	—	+	—	—
72	+	+	—	+	44·0	29·3	10·0	16·6	—	—	—	—	—	—	—	—	+	—	+	—	—	—	—
73	—	+	—	—	56·6	20·6	15·3	5·3	2·0	—	—	+	—	—	—	—	—	+	—	—	—	—	—
74	—	+	—	—	52·2	27·1	7·1	12·9	0·6	—	—	—	—	—	—	—	—	+	+	—	+	—	—
75	—	—	—	—	30·0	50·0	11·3	6·6	2·0	—	—	—	—	—	—	—	—	—	—	—	—	—	—
76	+	—	—	—	26·0	46·0	7·3	20·0	0·6	—	—	—	—	—	—	—	—	—	—	—	—	—	+
77	+	—	—	—	39·3	39·3	7·3	13·3	0·6	—	—	—	—	+	—	+	—	—	—	—	—	—	—
78	+	—	—	+	66·6	22·6	6·0	3·3	1·3	—	—	—	+	—	—	+	+	—	—	—	+	—	—

Serial No. of those examined	URINE: Albumen	URINE: Bile	URINE: Sugar	URINE: *Schistosoma* ova	BLOOD: Differential Count per cent.: Polymorpho-nuclears	Lymphocytes	Large Mononuclears	Eosinophils	Transitionals	Nucleated reds	BLOOD: Malaria Parasites: Benign tertian	Subtertian	BLOOD: *Filaria*: *perstans*	*loa*	*bancrofti*	FAECES: Ankylostomes	*Ascaris lumbricoides*	*Trich. trichiura*	*Strongyloides*	*Schistosoma* ova	*Entamoeba coli*	*Entamoeba histolytica*	*Trichomonas intestinalis*
79	+	—	—	—	32·5	29·3	7·5	30·0	0·6	—	—	—	—	—	—	—	+	—	—	—	—	—	—
80	—	—	—	—	56·6	26·0	7·3	10·0	—	—	—	—	+	—	—	—	+	—	—	—	—	—	—
81	—	—	—	—	34·6	42·0	12·0	10·0	1·3	—	—	—	—	—	—	—	+	—	—	—	+	—	—
82	+	+	—	—	55·3	31·6	7·3	6·6	—	—	—	—	—	—	—	+	—	+	—	—	+	—	—
83	—	—	—	—	36·0	50·6	8·6	2·6	2·0	—	—	—	—	—	—	—	+	+	—	—	—	—	—
84	+	—	—	—	32·6	40·6	10·6	15·3	1·3	—	—	—	—	—	—	—	+	—	—	—	+	—	—
85	—	—	—	—	35·3	39·3	14·0	10·0	1·3	—	—	+	—	—	—	+	—	+	—	—	—	—	—
86	—	—	—	—	32·0	25·3	10·0	32·6	—	—	—	—	—	—	—	—	+	+	—	—	—	—	—
87	—	—	—	—	33·3	34·0	14·0	18·0	0·6	—	+	—	—	—	—	—	—	+	—	—	+	—	+
88	—	—	—	—	24·6	46·6	9·3	17·3	2·0	—	—	—	—	—	—	—	+	—	—	—	—	—	—
89	+	+	—	—	46·6	40·0	9·3	3·3	0·6	—	—	—	+	—	+	—	+	—	—	—	—	+	—
90	+	—	—	—	30·0	38·0	8·0	22·6	1·3	—	—	—	—	—	—	—	—	—	—	—	—	—	—
91	—	—	—	—	38·6	45·3	10·0	4·6	1·3	—	—	—	—	—	—	—	—	—	—	—	—	—	—
92	—	—	—	—	38·6	36·0	11·3	14·0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
93	—	—	—	—	36·4	46·7	8·4	7·8	0·6	—	—	—	—	—	—	—	—	—	—	—	—	—	—
94	—	—	—	—	39·3	34·0	13·3	12·0	1·3	—	—	—	—	—	—	—	—	—	—	—	+	—	—
95	—	—	—	—	47·3	24·6	18·0	7·3	2·6	—	—	+	—	—	—	+	—	—	—	—	—	—	—
96	—	—	—	—	45·3	22·6	10·6	18·6	2·6	—	—	—	—	—	—	—	+	—	—	—	—	—	—
97	—	—	—	—	34·0	37·3	10·0	16·0	2·6	—	—	—	—	—	—	—	+	—	—	—	—	—	—
98	+	—	—	—	48·6	35·3	7·3	8·0	0·6	—	—	—	—	—	—	—	—	—	—	—	—	—	—
99	+	—	—	—	46·0	18·1	8·0	27·3	0·6	—	—	—	—	—	—	—	—	—	—	—	—	—	—
100	—	—	—	—	34·0	20·6	8·6	36·0	0·6	—	—	—	—	—	—	+	—	—	—	—	+	—	—

Entamoeba tetragena present 4 %.

Percentage of mononuclear leuocyctes over 10 % = 27.

GOLD COAST
NORTHERN TERRITORIES

AFRICA 1:1,000.000

PART OF SHEET 60

Topographical Section, General Staff., Nº 2146

REPORT ON THE EXAMINATION OF NORMAL AND INOCULATED GUINEA-PIGS

BY

MAJOR (now LIEUTENANT-COLONEL) D. S. HARVEY, M.D., Ch.B. (Glas.), R.A.M.C.

Examination of Blood Films from normal Guinea-pigs

In all, twenty-five guinea-pigs were examined. Very thin films were made from blood taken from the ear. These films, if Giemsa's stain was used, were fixed wet in osmic acid vapour and stained overnight in weak stain, washed, dried and cleared with acetone; if Leishman's stain was used, they were dried in air, fixed with methyl alcohol, treated with fresh serum, and stained for twenty minutes.

One hour and a half was given to the examination of each slide, and, as a rule, two slides were examined from each animal.

These examinations were spread over three months, and during this time none of the guinea-pigs died.

In practically every slide examined, one or two bodies were found which simulated 'paraplasmata'; some of which are figured and are described in detail. These bodies could be divided into the following classes:—

(*a*) Extraneous, such as bacteria and deposit, sometimes lying between and sometimes on the red cells.

(*b*) Folds and tears in the red cells with or without granules.

(*c*) Polychromatophilia of the red cells with granular stippling.

(*d*) Occasionally, small blue-staining bodies with a granule, not to be accounted for by *a*, *b* or *c*, and to all appearance identical with the 'Seidelin bodies.'

(*e*) Kurloff bodies.

I laboured under the disadvantage of never having had the opportunity of studying the *Paraplasma flavigenum* under the microscope, but many of the bodies seen and figured resembled the pictures closely.

Examination of Guinea-pigs received from Dr. Seidelin and also of those inoculated therefrom

From Table I it will be seen that four guinea-pigs were received at the Royal Army Medical College from West Africa on 21st February, 1914, i.e., Nos. 1, 2, 11, and 12. No. 11 died on 22nd February, 1914, and Nos. 1, 2, and 12 are still alive (30th June, 1914).

Twenty-nine guinea-pigs have been inoculated from these strains, as shown in the table; blood films were taken daily for some time, and, latterly, twice a week. More than 500 slides have been taken, and the majority of them were stained and examined. Some of the appearances seen are figured. Duplicate unstained films have been paraffined and stored for subsequent reference.

As in the normal guinea-pigs, no definite protozoic parasites of the red cells were seen, although some 'bodies' which simulated such parasites were observed, but rarely, not more commonly than in the normal animals.

Post-mortem examinations were made on two of the guinea-pigs, Nos. 11 and 28, which had died, and on eight that had been killed for purposes of examination; ten in all. Special attention was directed to the following points:—

(*a*) Examination of smears or touch preparations from organs, especially lung and spleen.

(*b*) Macroscopic condition of stomach and other organs.

(*c*) Examination of urines.

I had the opportunity of examining a stained preparation sent by Dr. Seidelin showing some stages of a protozoal parasite in the lung of a guinea-pig; in none of the ten guinea-pigs mentioned above was anything resembling this condition seen.

There was no albumen in the urine of No. 11, and no petechial haemorrhages or inflammation of the stomach wall. In No. 28, on the other hand, there was albumen in the urine and some inflammation of the wall of the stomach. Of the eight which were killed, all appeared healthy, and the stomachs were normal in appearance.

Examination of urines, post-mortem and during life (see Table II).

The urines were collected during life by placing the guinea-pigs in a glass bowl for an hour or so. Post-mortem, the urine was drawn

off from the bladder by means of a glass pipette with rubber teat. Of eighteen inoculated guinea-pigs examined, seven had albumen in the urine, and of ten normal guinea-pigs examined, one had albumen in the urine (this was a female).

Further examinations were undertaken, as it was found that two of the inoculated guinea-pigs showed albumen in the urine once, but when examined on a later occasion the urine was free.

The kidney of one of the guinea-pigs which showed albumen in the urine was hardened for section cutting.

Temperature Charts

The temperatures of all these guinea-pigs were taken twice daily for three weeks after inoculation.

The normal temperature of the guinea-pigs at the College is apparently between 102° and 103°, and keeps fairly steady.

A curious fact is that on the whole, apart from one or two rises to 104°, the temperature of the inoculated guinea-pigs was lower than that of the normal.

Some charts are extracted and appended.*

Post-mortem Examinations of Guinea-pigs Inoculated from 'Infected' Guinea-pigs

Guinea-pig No. 11.—Died 22nd February, 1914. No albumen, stomach normal. Smears made and examined.

Guinea-pig No. 28.—Died 8th March, 1914. Albumen present, inflammation of stomach wall. Smears made and examined.

Guinea-pig No. 30.—Killed 27th March, 1914. Bladder empty, no inflammation of stomach wall. Smears made and examined.

Guinea-pig No. 31.—Killed 27th March, 1914. Albumen present, stomach normal, healthy.

Guinea-pig No. 29.—Killed 27th March, 1914. No albumen, stomach normal, healthy. Smears made and examined, nil.

Guinea-pig No. 39.—Killed 6th April, 1914. Albumen present, stomach normal. Smears made and examined.

Guinea-pig No. 57.—Killed 6th April, 1914. No albumen, stomach normal. Smears made and examined.

Guinea-pig No. 36.—Killed 16th April, 1914. No albumen, stomach normal. Smears made and examined.

Guinea-pig No. 40.—Killed 24th April, 1914. Albumen present, stomach normal. Smears made and examined.

Guinea-pig No. 84.—4th May, 1914. No albumen, stomach normal. Smears made and examined.

The urine of No. 84 examined on 23rd April, 1914, contained albumen.

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* *Vide* pp. 745-747 *infra*.

TABLE I.—GUINEA-PIGS RECEIVED FROM WEST AFRICA, WITH DATES OF INOCULATION OF LOCAL GUINEA-PIGS

No. 1 (W.A.)		No. 2 (W.A.)		No. 11† (W.A.) 22.2.14			No. 12 (W.A.)		No. 92 (Liverpool series)		
*No. 30 27.3.14	23.2.14	*No. 31 27.3.14	23.2.14	†Nos. 28 and 8.3.14	*29 27.3.14	23.2.14	*No. 36 16.4.14	27.2.14		No. 93	24.4.14
*No. 39 6.4.14	2.3.14	*No. 40 15.4.14	2.3.14	No. 49 9.3.14	*No. 57 6.4.14	10.3.14	No. 48	7.3.14		No. 98	4.5.14
No. 55	10.3.14	No. 56	10.3.14	No. 60 16.3.14	No. 63	16.3.14	No. 64	20.3.14		No. 103	11.5.14
No. 61	16.3.14	No. 62	16.3.14	No. 70 24.3.14	No. 73	24.3.14	No. 74	30.3.14	Killed 25.5.14	No. 108	19.5.14
No. 71	24.3.14	No. 72	24.3.14	No. 79 3.4.14			No. 82	7.4.14	Killed 3.6.14	No. 114	25.5.14
		No. 78	2.4.14	*No. 84 9.4.14		4.5.14				No. 118	3.6.14
		No. 83	9.4.14	No. 91 17.4.14						No. 122	13.6.14
		No. 90	17.4.14							No. 128	23.6.14
										No. 152	2.7.14

* Killed. † Died. Remainder alive, 30th June, 1914.

TABLE II.—RESULTS OF EXAMINATION OF URINES OF INOCULATED GUINEA-PIGS

Guinea-pig No.	Sex	Albumen	When examined
11	...	Absent	Post-mortem
28	...	Present	,,
30	Female	Absent	,,
31	Female	Present	,,
29	Male	Absent	,,
39	...	Present	,,
57	...	Absent	,,
36	...	Absent	,,
90	Female	Absent	During life
92	Female	Present	,,
84	Female	Present	,,
40	Male	Present	Post-mortem
1	Male	Present	During life
2	Female	Absent	,,
62	Female	Absent	,,
73	Male	Absent	,,
71	Male	Absent	,,
51	Female	Absent	,,

18 guinea-pigs. 7 albumen

TABLE III.—EXAMINATION OF URINE OF NORMAL GUINEA-PIGS

Guinea-pig No.	Sex	Albumen	When examined
1	...	Absent	During life.
2	Female	Present	,,
3	Male	Absent	,,
4	Female	Absent	,,
5	Female	Absent	,,
6	Male	Absent	,,
7	Male	Absent	,,
8	Female	Absent	,,
9	Female	Absent	,,
10	Male	Absent	,,

10 guinea-pigs. 1 albumen

Table IV.—Series of Guinea-pigs Received from West Africa, and those Inoculated from them

Guinea-pig No.	Date of inoculation	*Paraplasma*	Blue bodies	Killed	Died	Spleen	Lung	Stomach, haemorrhages	Urine, albumen
1	?	Present	...	...	...	...	...	...	...
2	?	Present	...	...	...	...	...	...	Absent
11	?	Present	...	...	23.2.14	...	...	Absent	Absent
12	?	Present	...	...	...	...	...	...	...
28	23.2.14	Present	Present	...	8.3.14	...	...	Present	Present
29	23.2.14	Present	...	27.3.14	...	...	...	Absent	Absent
30	23.2.14	...	...	27.3.14	...	...	...	Absent	Absent
31	23.2.14	Present	...	27.3.14	...	...	Blue bodies present	Absent	Absent
36	27.2.14	...	...	16.4.14	...	...	...	Absent	Absent
39	2.3.14	Present	Present	6.4.14	...	...	...	Absent	Absent
40	2.3.14	...	...	24.4.14	...	...	...	Absent	Absent
48	7.3.14	Present	...	...	...	...	...	...	...
49	9.3.14	Present	...	...	...	...	...	...	...
55	10.3.14	...	...	...	...	...	...	...	...
56	10.3.14	...	...	...	...	...	...	...	...
57	10.3.14	Present	Present	6.4.14	...	...	...	Absent	Absent
60	16.3.14	...	...	...	...	...	...	...	...
61	16.3.14	...	Present	...	...	...	...	...	...
62	16.3.14	Present	...	...	...	...	...	...	Absent
63	16.3.14	Present	...	...	...	...	...	...	...
64	20.3.14	...	...	...	...	...	...	...	...
70	24.3.14	Present	Present	12.5.14	...	Blue bodies present	Blue bodies present	Absent	Present
71	24.3.14	Absent	...	11.6.14	...	...	...	Present	Present
72	24.3.14	...	...	...	...	...	...	...	...
73	24.3.14	...	...	...	...	...	...	...	...
74	30.3.14	Absent	...	...	...	...	...	...	Absent
78	2.4.14	Absent	...	9.6.14	...	...	...	Present	Absent
79	3.4.14	Absent	...	9.6.14	...	...	...	Absent	Absent
82	7.4.14	...	...	...	...	...	...	...	Absent
83	9.4.14	...	...	...	...	...	...	...	Absent
84	9.4.14	Absent	...	4.5.14	...	...	...	Present 24.4.14	...
90	17.4.14	...	...	...	...	...	...	Absent 4.5.14	...
91	17.4.14	...	...	...	...	...	...	Absent	...

TABLE V.—LIVERPOOL SERIES OF GUINEA-PIGS

Guinea-pig No.	Date of inoculation	Peripheral Blood: *Paraplasma*	Peripheral Blood: Blue bodies	Killed	Died	Spleen	Lung	Stomach, haemorrhages	Urine, albumen
92	17.4.14	Present	...		...	...	...	...	Present 23.5.14 Absent 28.5.14
93	24.4.14	Absent	...	...	...	...	...	...	...
98	4.5.14	Present	Present	...	...	...	...	...	...
103	11.5.14	Present	...	...	...	...	...	...	...
108	19.5.14	Present	...	25.5.14	...	...	...	Present	Present 16.5.14 Absent 21.5.14
114	25.5.14	Absent	...	3.6.14	...	...	...	Absent	Absent 2.6.14 Present post-mortem
118	3.6.14	Absent	...	...	...	...	...	...	Absent

NOTE.—No. 92 was an infected guinea-pig received from Liverpool; the remainder were local guinea-pigs.

TABLE VI.—SERIES OF GUINEA-PIGS INOCULATED FROM NORMAL GUINEA-PIGS

Guinea-pig No.	Peripheral Blood: Date of inoculation	Peripheral Blood: *Paraplasma*	Blue bodies	Killed	Died	Spleen	Lung	Stomach, haemorrhages	Urine, albumen
2*a*	19.5.14	Present	Present	25.5.14	...	Blue bodies present	...	Present*	Absent 16.5.14 Absent 18.5.14 Absent 21.5.14
3*a*	19.5.14	Present	...	23.6.14	...	...	...	Present†	Absent 16.5.14 Absent 18.5.14 Absent 21.5.14 Present post-mortem
4*a*	19.5.14	Present	...	29.5.14	...	Blue bodies present	Blue bodies present	Absent	Absent 16.5.14 Absent 18.5.14 Absent 21.5.14

* Injection of vessels in serous coat and small haemorrhages beneath mucous membrane.

† Small haemorrhages around pylorus.

Notes on Examination of Urines of Inoculated Guinea-pigs

Guinea-pig No. 31, female. Post-mortem, *27th March*, 1914.—Urine turbid, clears with effervescence on addition of acetic acid. On heating, shows distinct small clots not dissolved by acid. Cold nitric acid gives a thick solid film at junction of fluids not immediate. ? Nitrates.

Guinea-pig No. 29, male. Post-mortem, *27th March*, 1914.—Urine turbid, clears with effervescence on addition of acetic acid. Deposit stained, no cells. amorphous carbonates ? Heating, no clot ; nitric acid, no film.

Guinea-pig No. 39. Post-mortem, *6th April*, 1914.—Urine turbid, clears on addition of acetic acid with effervescence, on heating again becomes turbid. Not cleared by addition of acid, but clears when alkali is added. No film on addition of nitric acid in the cold.

Guinea-pig No. 57. Post-mortem, *6th April*, 1914.—Urine turbid, clears on addition of acetic acid with effervescence. No turbidity on heating, no ring with nitric acid in the cold.

Guinea-pig No. 36. Post-mortem, *16th April*, 1914, on which day the animal was killed.—Urine turbid, not cleared by addition of acetic acid although effervescence takes place. No ring on addition of nitric acid in the cold.

Guinea-pig No. 90, female. *22nd April*, 1914.—Urine dark coloured, turbid, clears on addition of acetic acid. On heating becomes cloudy, dark flocculent precipitate not cleared by addition of acetic acid in excess.

24th April, 1914.—Urine cleared by acid, no cloud on heating.

Guinea-pig No. 92, female. *24th April*, 1914.—Urine cleared by acid, distinct cloud on heating.

28th May, 1914.—No albumen.

Guinea-pig No. 84, female. *24th April*, 1914.—Urine does not quite clear on adding acid. On heating, becomes densely clouded ; not dissolved by excess of acid.

Post-mortem, *4th May*, 1914.—No albumen.

Guinea-pig No. 40. Post-mortem, 24th *April*, 1914.—Urine, albumen present.

Guinea-pig No. 1. *25th April*, 1914.—Urine does not quite clear on addition of acid. Slight cloudiness not dissolved by acid. Cloudiness with nitric acid in the cold.

Guinea-pig No. 2. *25th April*, 1914.—Urine does not quite clear on addition of acid. Slight cloud on heating not dissolved by acid. No cloud with nitric acid.

Guinea-pig No. 62. *25th April*, 1914.—Urine clears on addition of acid, no cloud on heating with nitric acid.

Guinea-pig No. 73. *25th April*, 1914.—No albumen.

Guinea-pig No. 71. *25th April*, 1914.—No albumen.

Post-mortem, *11th June*, 1914.—Small quantity of urine drawn off from bladder. Does not completely clear on addition of acetic acid, and on boiling becomes solid. Nitric acid in cold, dense cloud at junction of fluids. Some mucin and serum albumen.

Guinea-pig No. 51. *25th April*, 1914.—No albumen.

Guinea-pig No. 84. Post-mortem, 4*th May*, 1914.—No albumen.

Guinea-pig No. 70. 12*th May*, 1914.—During life, turbid urine clears with acid, heavy cloud on heating.

Post-mortem, no albumen.

Guinea-pig No. 93. 12*th May*, 1914.—Turbid urine, clears with acid, heavy cloud on heating.

28*th May*, 1914.—No albumen.

Guinea-pig No. 108. Post-mortem, 25*th May*, 1914.—No albumen.

Guinea-pig No. 114. 25*th May*, 1914.—Urine clears on addition of diluted acetic acid, but becomes cloudy on heating. Cloud not re-dissolved on rendering acid with acetic acid, but on adding strong nitric acid there is marked ebullition and the urine clears.

2*nd June*, 1914.—No albumen.

Post-mortem, 3*rd June*, 1914.—The urine on addition of acetic acid shows a clot not dissolved, but increased by heat or further addition of acid. Gas given off on addition of acetic acid tested with baryta water = CO_2. Deposit tested for phosphates ; negative.

Guinea-pig No. 49. Post-mortem, 29*th May*, 1914.—On heating, the acid urine shows a slight cloud, not dissolved by the addition of more acid.

Guinea-pig No. 74. 3*rd June*, 1914.—No albumen.

Guinea-pig No. 78. 3*rd June*, 1914.—No albumen.

Post-mortem, 9*th June*, 1914.—Urine bloodstained ; slight albumen.

Guinea-pig No. 79. 3*rd June*, 1914.—No albumen.

Post-mortem, 9*th June*, 1914.—No albumen.

Guinea-pig No. 82. 3*rd June*, 1914.—No albumen.

Guinea-pig No. 83. 3*rd June*, 1914.—No albumen.

Examination of Urine of Guinea-pigs Inoculated with Blood from Normal Guinea-pigs

Guinea-pig 2a

16*th May*, 1914.—During life. No albumen.
18*th May*, 1914.—During life. No albumen.
21*st May*, 1914.—During life. No albumen.
25*th May*, 1914.—Post-mortem. No albumen.

Guinea-pig 3a

16*th May*, 1914.—No albumen.
18*th May*, 1914.—No albumen.
21*st May*, 1914.—No albumen.
23*rd June*, 1914.—On heating the acid urine in a water bath, there was a dense cloud of coagulated albumen.

Guinea-pig 4a

16*th May*, 1914.—No albumen.
18*th May*, 1914.—No albumen.
21*st May*, 1914.—No albumen.

Further Remarks on the Examination of Inoculated and Normal Guinea-pigs

Four guinea-pigs were received from West Africa on the 21st of February, 1914, and twenty-nine normal guinea-pigs have been inoculated from this strain. Of the four West African guinea-pigs, one, No. 11, died the night after its arrival at the College. On post-mortem examination, no haemorrhages were found in the stomach and no albumen was present in the urine.

Of the twenty-nine local guinea-pigs inoculated from the West African strain, as shown in Table IV, one died (No. 28). The post-mortem examination showed haemorrhages in the mucous membrane of the stomach and albumen in the urine. This guinea-pig died on the 8th of March, 1914, and the post-mortem was performed on the following day.

Examination of the Peripheral Blood

The blood of all these guinea-pigs was examined on several days, and bodies resembling the *Paraplasma flavigenum* were found in fifteen.

Post-mortem Examinations

Twelve of these guinea-pigs were killed; in ten the mucous membrane of the stomach was normal, whilst in two there were haemorrhages in the mucous membrane.

Note.—The first eight, which had not fed since the morning, were killed by chloroform in the afternoon; they were examined immediately after death, and in all, the mucous membrane of the stomach was normal.

As it was thought that the condition of the mucous membrane might vary according to the condition of the stomach as regards food, two guinea-pigs were selected, Nos. 78 and 79. No. 78 was fed as usual in the morning at 8.0 a.m. and killed at 11.0 a.m. on the 9th of June, 1914. No. 79 was not fed, and was also killed at 11.0 a.m. The stomach of No. 78 showed small petechial haemorrhages and injection of the vessels of the stomach wall (serous surface). The stomach of No. 79 showed no haemorrhages and no injection of vessels.

As both these animals had been inoculated from (?) infected animals on the 2nd of April, 1914, a third animal was taken. This had been inoculated with blood from a normal guinea-pig. This guinea-pig was killed in the morning immediately after feeding, and small haemorrhages were found in the mucous membrane and there was some injection of the vessels of the stomach wall.

As it was thought that the haemorrhages in the wall of the stomach, as recorded by Dr. Seidelin, might be due to post-mortem changes, a guinea-pig, No. 71, was taken and killed at 4.0 p.m. on the 11th of June, 1914. The post-mortem examination was performed at 11.0 a.m. on the 12th of June. The mucous membrane of the stomach was found to be stippled with what appeared to be small petechial haemorrhages, but when the stomach was placed in Kaiserling fluid all these small haemorrhages disappeared, and on cutting a section of the stomach wall no red cells could be seen, only granular débris (haemoglobin).

The other organs of these guinea-pigs appeared healthy. In one there were four or five small haemorrhages below the capsule of the kidney, which organ was otherwise normal; and in another there were two or three small superficial haemorrhagic infarcts in the liver, not of recent date.

Urine

The examination of the urine of guinea-pigs is liable to fallacy, because, as a rule, only a few drops of urine can be obtained during life and the urine is invariably turbid. This turbidity is due to the presence of large quantities of alkaline carbonates. The urine, as a rule, can be cleared by the addition of acetic acid; brisk effervescence takes place, and the gas given off can be proved to be CO_2. There are no phosphates present.

For the reasons given above, it could not always be definitely stated whether albumen was, or was not, present. Occasionally a cloud comes down on heating which is not dissolved by the addition of acid, and yet it does not give the impression of being albumen, rather that of carbonates reprecipitated by heat and not soluble in acid. On the other hand, in several instances, there was undoubted albumen present, as shown both by the nitric acid test and by heating the acid urine.

Twenty-five samples of urine were examined from the series of guinea-pigs; six showed the presence of albumen, whereas in eighteen the result was negative. One sample was tinged with blood. Five of the six positive examinations were made post-mortem. Two guinea-pigs in which during life the urine had been found to be free from albumen were killed at 4.0 p.m. The post-mortem was performed the following day, and in both instances the urine was found to be loaded with albumen, becoming almost solid on boiling in the water bath.

One of these guinea-pigs (No. 71) had been inoculated from No. 61 of the West African series on the 24th of March, 1914, and was killed on the 11th of June, 1914; the other (No. 3*a*) had been inoculated from a normal guinea-pig on May the 19th, and was killed on June the 23rd. The urine of this animal had been examined on four occasions during life, with negative results, yet on post-mortem examination the urine was loaded with albumen.

Examination of 'Touch' Preparations from the Lungs and Spleen

In all the post-mortem examinations 'touch' preparations were made from the lung and spleen, and in one instance a portion of a kidney was examined microscopically, in another the liver.

In two instances 'blue bodies' were found in the touch preparation; these were blue stained protoplasmic masses about the size of a red cell with chromatin granules, and gave the impression of being portions of the cells of the spleen or lung, and not of being parasites.

Series of Guinea-pigs inoculated from Normal Guinea-pigs

These three guinea-pigs were inoculated from normal guinea-pigs in exactly the same manner as the series of infected guinea-pigs. Blood (0·2 c.c.) was drawn from the vein of a normal guinea-pig and was inoculated subcutaneously into the experimental animal. They were numbered 2*a*, 3*a*, and 4*a* (see Table VI).

Bodies resembling the *Paraplasma flavigenum* were found in the peripheral blood of all three, and in touch preparations of lung and spleen from No. 4*a* 'blue bodies' were found and were very numerous.

The stomach of No. 2*a* showed some injection of vessels and a few small submucous haemorrhages; this animal was killed while feeding.

The stomach of No. 3*a* showed some staining of the mucous membrane, but this only very slight, and not in any way comparable with the condition of the stomach wall in No. 71. No. 3*a* was killed on the 23rd of June, 1914, and the post-mortem was done on the following day. There were no marked changes in any of the organs, and in smears the red cells stained well and were not broken down, as they were in the case of 71.

General Conclusions

1. Bodies resembling *Paraplasmata* were found in the red cells, both of normal and of inoculated animals.

2. If the guinea-pigs are killed while feeding, the vessels of the stomach wall will be found injected and a few small submucous haemorrhages may be present.

3. If the post-mortem examination is delayed for some hours after death an extreme condition of haemorrhagic (haemoglobinuric) stippling may be found in the stomach wall. This coloration disappears in the mounting fluid, and no red cells can be found on section.

4. The examination of the urine of guinea-pigs is liable to fallacy owing to the extreme alkalinity and turbidity of the urine. Post-mortem, both in normal animals and in animals inoculated from others, albumen is almost invariably present in the urine, and becomes more marked the longer the urine is allowed to remain in contact with the bladder wall.

Liverpool Series

A guinea-pig, No. 92, was received from Liverpool on the 17th of April, 1914, which had been inoculated on the 16th of April, 1914, from an infected guinea-pig brought from Lagos. This strain has been kept going, as shown in Table No. I. None of the guinea-pigs in this series have died; two (Nos. 108 and 114) were killed.

The urine of No. 92 showed (?) albumen on May the 23rd, but no albumen on May the 28th; that of No. 93 on May the 12th showed albumen, but the examination was negative on May the 28th. No. 114 showed no albumen on the 2nd of June. It was killed on the 3rd of June, when the urine drawn off from the bladder contained albumen.

Ten examinations were made of the urine of these nine guinea-pigs. Of these, three gave a positive result as regards albumen, and in seven the result was negative.

In No. 108, which was killed in the morning while feeding, the stomach was injected, and one or two small haemorrhages were observed under the mucous membrane. Guinea-pig No. 114 was killed some hours after feeding, and the stomach showed no injection and no haemorrhages.

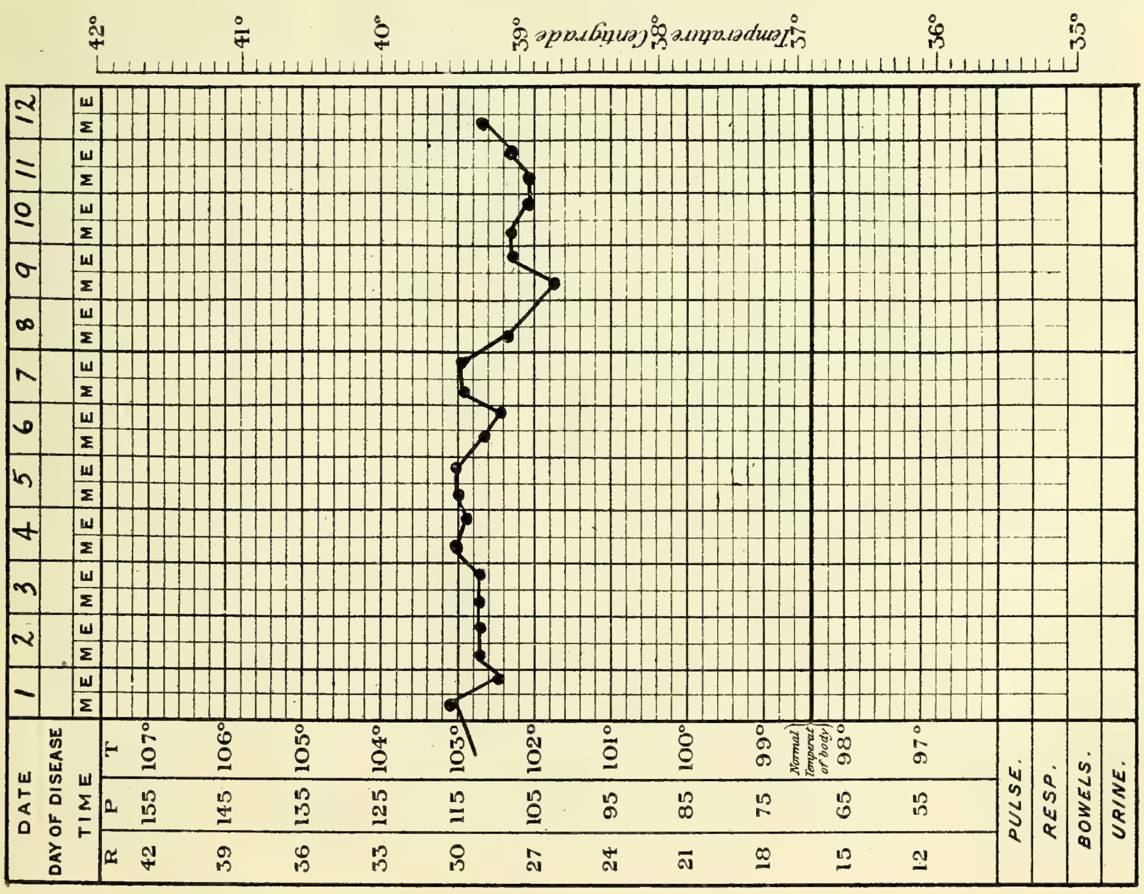


Chart 1. Normal Guinea-pig

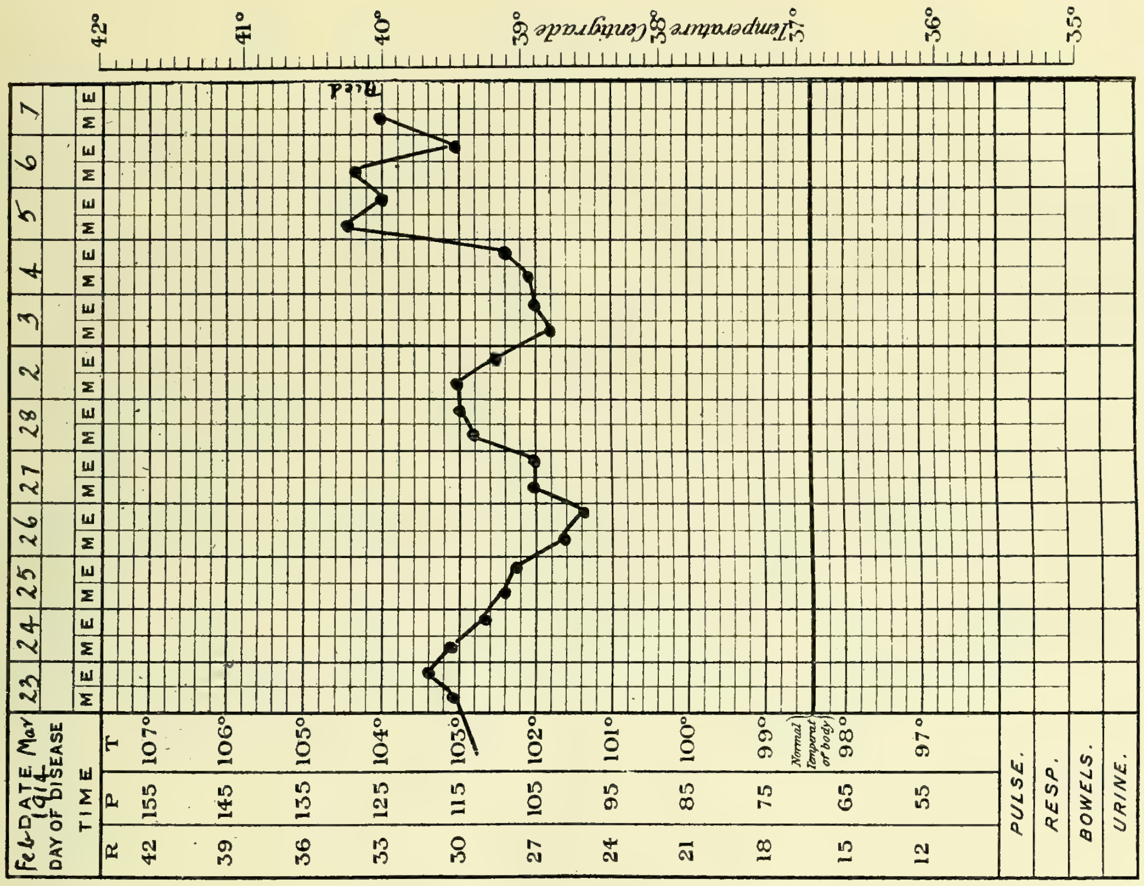


Chart 2. Guinea-pig 28 inoculated from 11

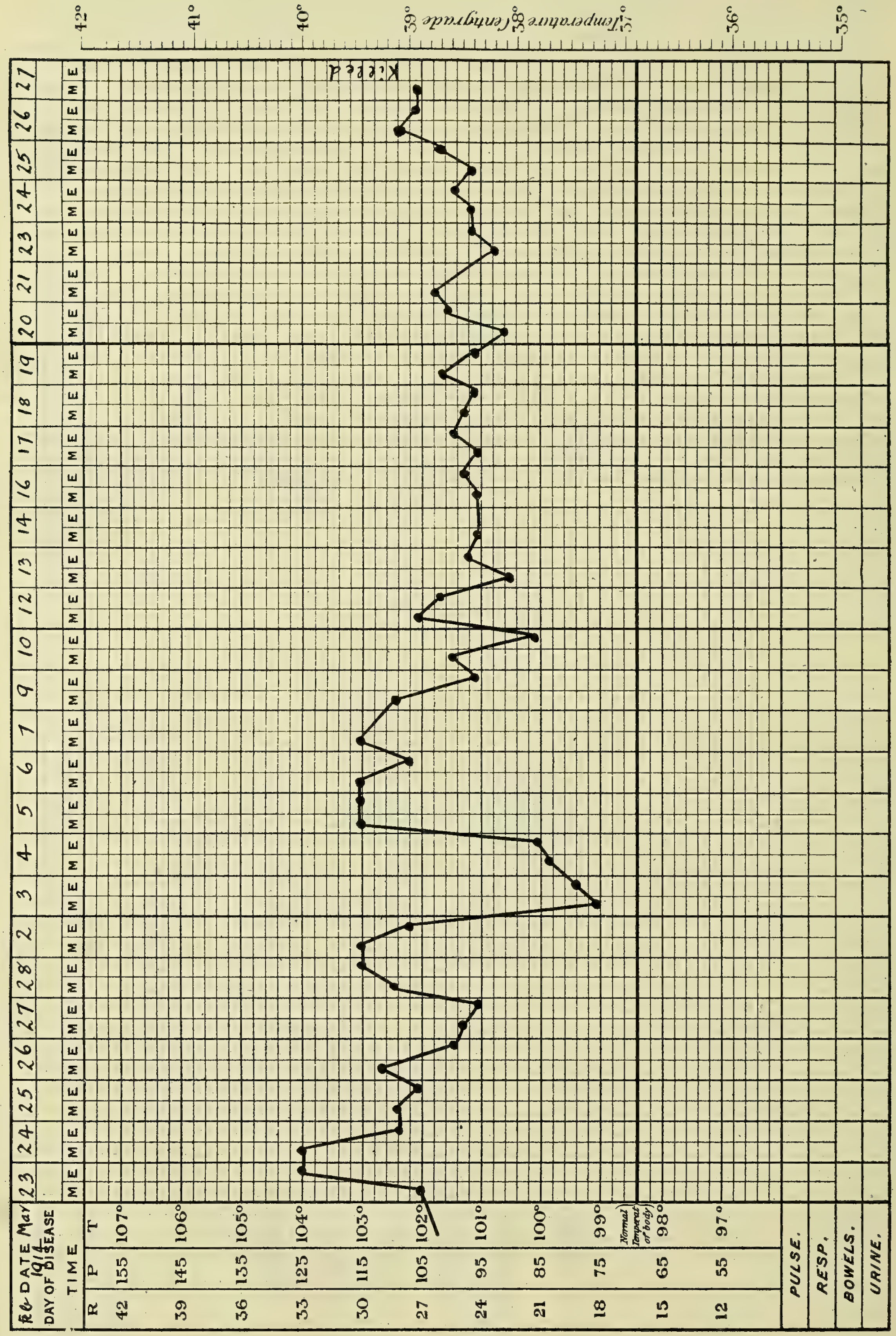


Chart 3. Y.F. Guinea-pig 30

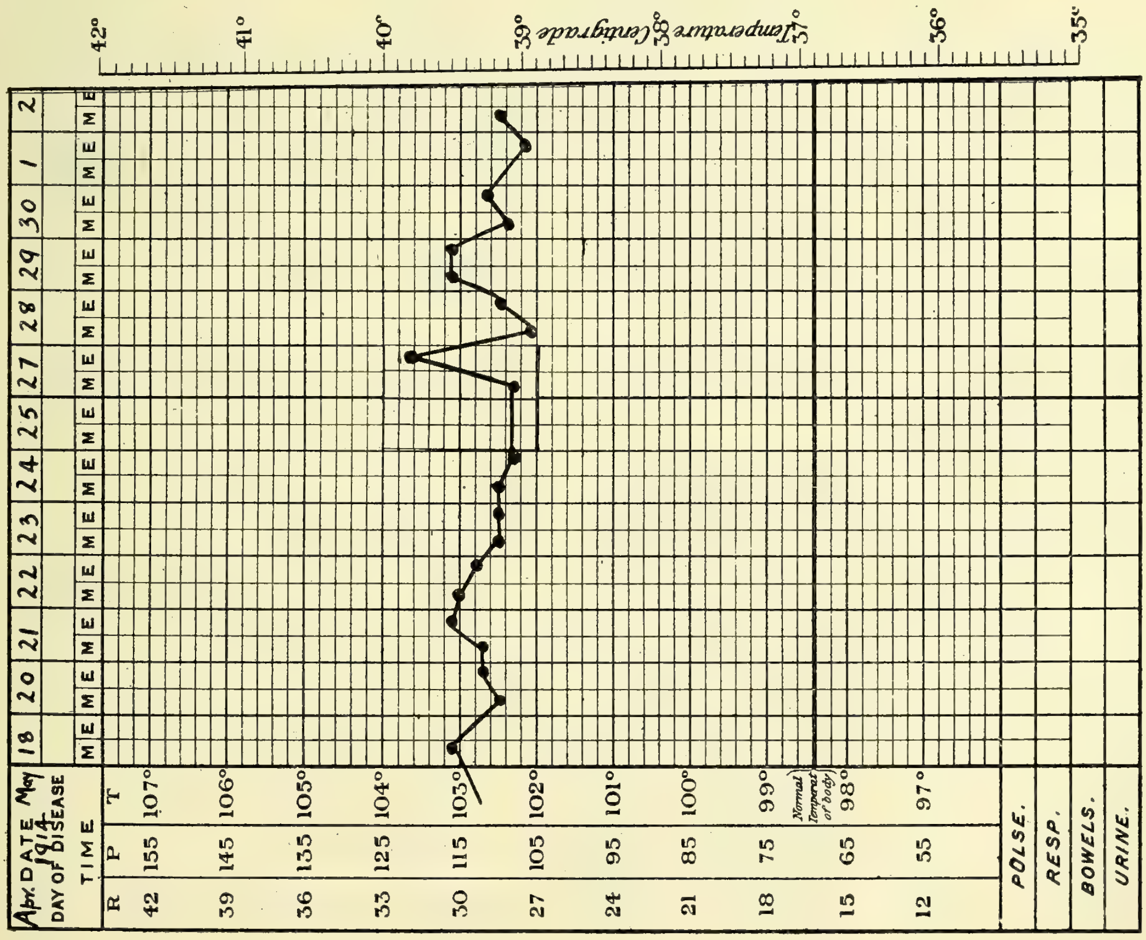


Chart 4. Guinea-pig 92

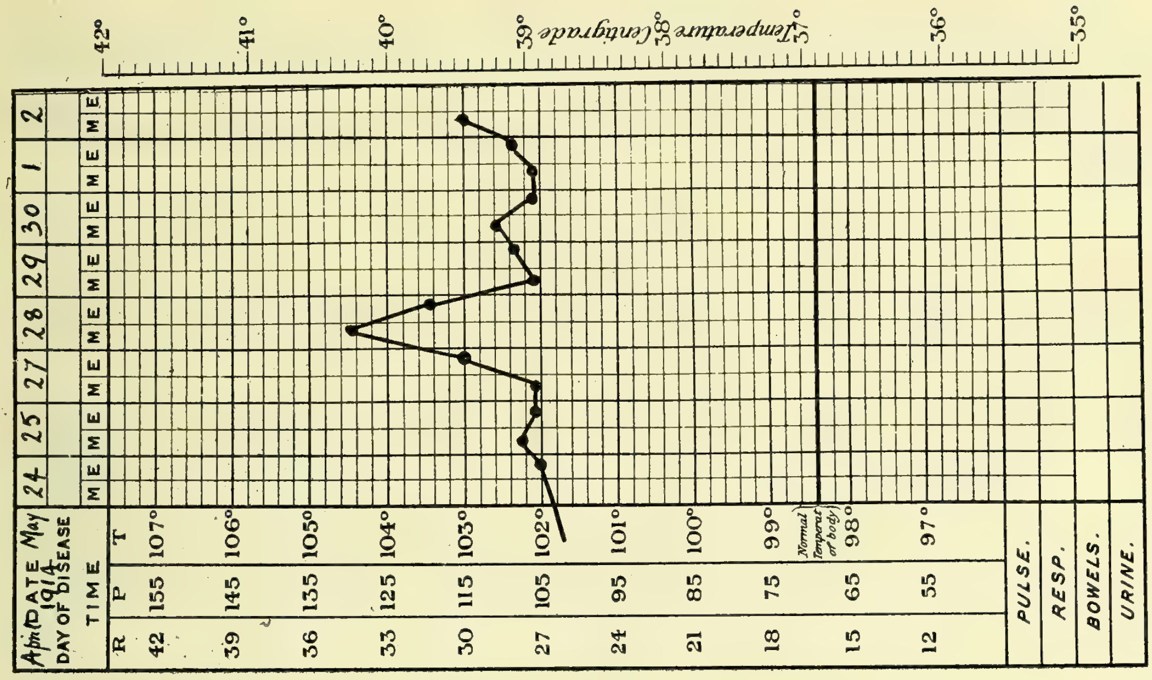


Chart 5. Guinea-pig 93 inoculated from 92

EXPLANATION OF PLATES

The figures have been outlined by means of Abbe's drawing apparatus. Zeiss's apochromatic immersion objective 2 mm., compensating ocular 12. Magnification 1,500 diameters.

Where not otherwise stated the figures were painted from films of peripheral blood.

Plate XVII

Figures painted from Leishman and Giemsa stained blood films of 25 normal English guinea-pigs.

Fig. 1 (G.-p. 2).—Small brownish-stained rod in red cell, no granule.

Fig. 2 (G.-p. 3).—Long ' tear ' in red cell. At certain points in the focus the rolled-up portion has a distinctly blue tinge ; at one end is a dark granule.

Fig. 3 (G.-p. 4).—A faintly-stained body in a red cell—? blood platelet.

Fig. 4 (G.-p. 4).—A vacuole in the red cell with a deeply-stained border.

Fig. 5 (G.-p. 4).—A ' tear ' in red cell.

Fig. 6 (G.-p. 4).—A blue crescentic-shaped body lying against a deformed red cell. Between the red cell and the blue there was a dark refractile granule, which did not give true chromatin reaction.

Fig. 7 (G.-p. 5).—Small vacuole in red cell with granule.

Figs. 8 and 9 (G.-p. 5).—Polychromatophil red cells showing granular degeneration and staining of bands in the stroma.

Fig. 10 (G.-p. 7).—Very faintly stained grey-blue body, with dark granule.

Fig. 11 (G.-p. 7).—Blue body, rod-shaped, with chromatin granule.

Fig. 12 (G.-p. 7).—Dark blue body with densely-stained borders.

Fig. 13 (G.-p. 9).—A long tear or fold in the red cell. Near one end a granule has lodged ; this granule was noticed to move along the fold while the cell was under observation.

Fig. 14 (G.-p. 9).—Small blue rod with chromatin granule.

Fig. 15 (G.-p. 9).—A larger similar body.

Fig. 16 (G.-p. 14).—The same.

Fig. 17 (G.-p. 17).—Chromatin granule with deep-stained body ; no blue protoplasm.

Fig. 18 (G.-p. 19).—Blue bodies free in the plasma—? bacterial.

Fig. 19 (G.-p. 20).—Chromatin granule.

Fig. 20 (G.-p. 20).—Chromatin granule with dark grey body.

Fig. 21 (G.-p. 20).—Vacuole in red cell with deep chromatin-stained margins and crossed by threads.

Fig. 22 (G.-p. 21).—Blue-stained rod and chromatin granule.

Fig. 23 (G.-p. 22).—Similar to Fig. 21.

Fig. 24 (G.-p. 22).—Large chromatin granule.

Fig. 25 (G.-p. 22).—Exceedingly minute blue body with granule.

Figs. 26-29 (G.-p. 23).—Similar to Fig. 25.

Fig. 30 (G.-p. 23).—Small blue body, but without granule.

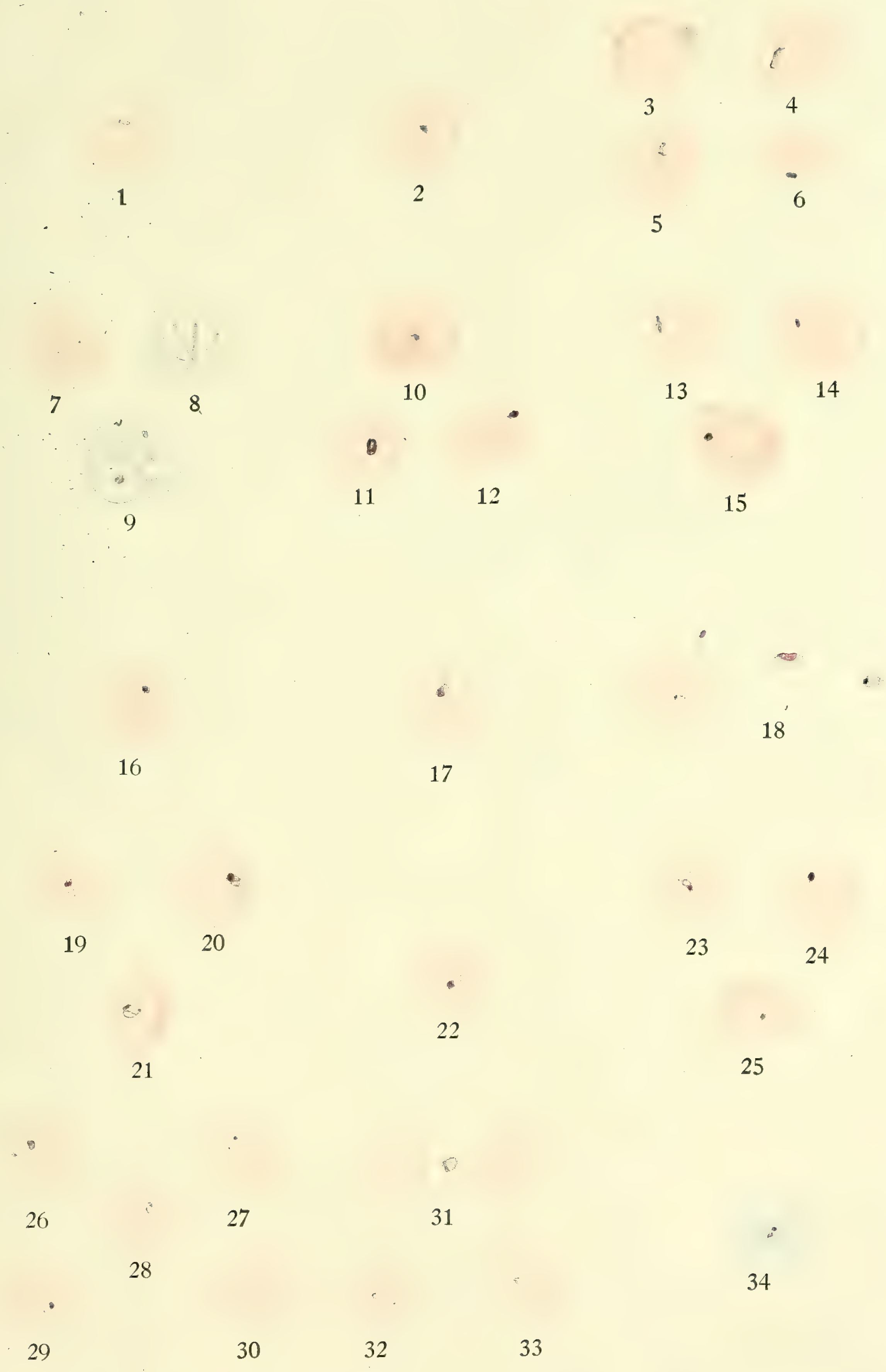
Fig. 31 (G.-p. 24).—Free body in plasma.

Fig. 32 (G.-p. 24).—Faint blue body and rod with chromatin granule.

Fig. 33 (G.-p. 24).—Similar body.

Fig. 34 (G.-p. 25).—A polychromatophil cell with dark-stained central portion, on which are two chromatin granules.

PLATE XVII.



D. S. Harvey pinx.

Plate XVIII

Figures painted from Leishman and Giemsa stained blood films or touch preparations from inoculated guinea-pigs.

Figs. 35 and 36 (G.-p. 1).—Blue-stained bodies in polychromatophil cells. (Giemsa.)

Fig. 37 (G.-p. 1).—Small blue body in red cell. (Leishman.)

Fig. 38 (G.-p. 1).—Small brownish-stained body.

Fig. 39 (G.-p. 2).—Blue-stained body with granule.

Fig. 40 (G.-p. 2).—Brownish rod-shaped body lying in a red cell. Central granule.

Fig. 41 (G.-p. 2).—Blue-stained body with granule.

Fig. 42 (G.-p. 11).—A small comma-shaped body with granule.

Figs. 43, 44, and 46 (G.-p. 12).—Blue bodies with granule in or on red cell.

Fig. 45 (G.-p. 12).—'Blue body' free in plasma.

Fig. 47 (G.-p. 28).—Small blue body in red cell.

Fig. 48 (G.-p. 28).—Degenerated Kurloff body in white cell in spleen touch.

Fig. 49 (G.-p. 28).—Blue body free, spleen touch.

Fig. 50 (G.-p. 28).—Large cell with pigment in protoplasm (spleen).

Figs. 51 and 52 (G.-p. 29).—Similar to Figs. 43 and 44.

Fig. 53 (G.-p. 31).—Giemsa-stained red cell, dark blue body with two red granules.

Fig. 54 (G.-p. 39).—Similar to Fig. 53.

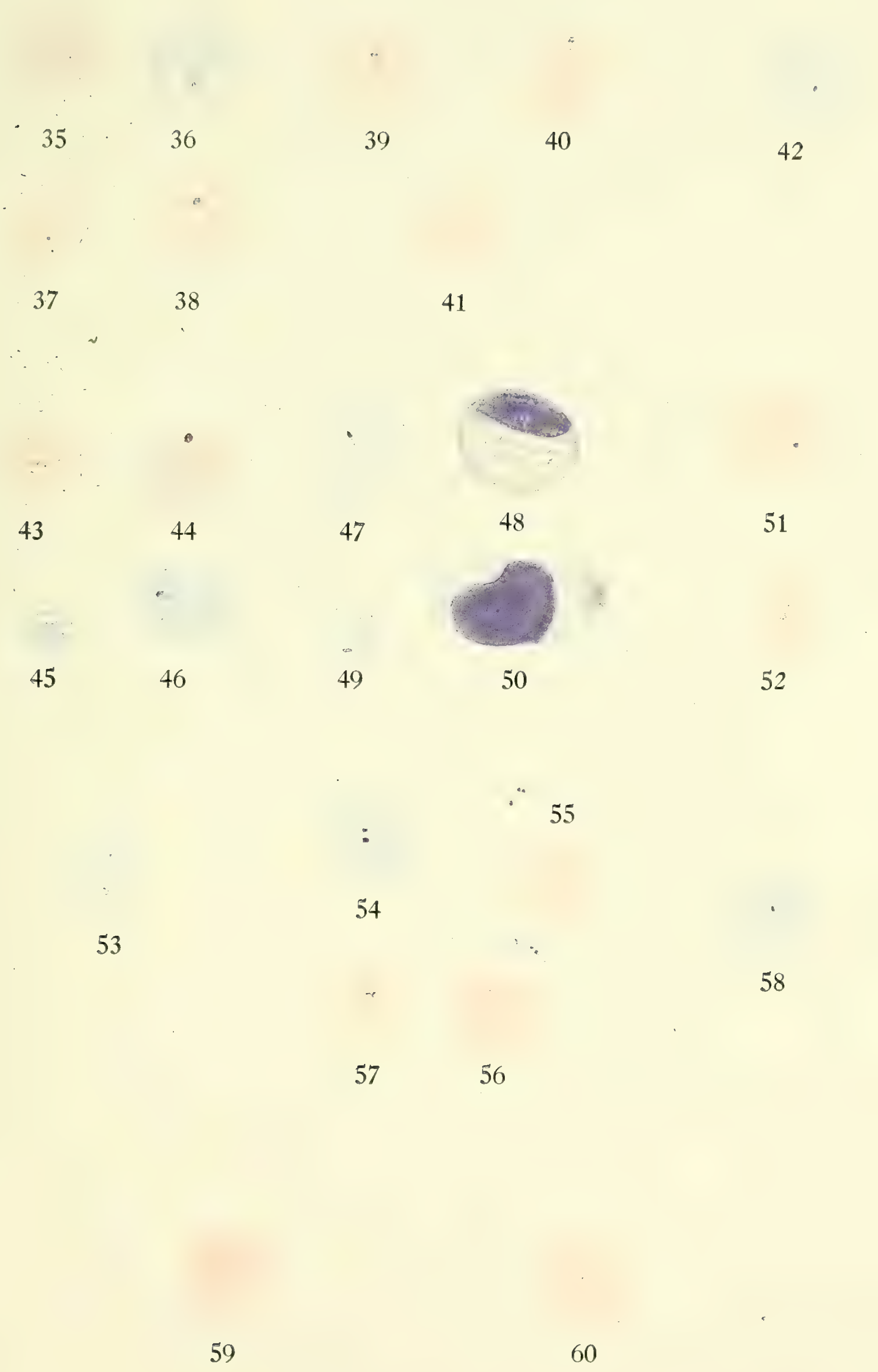
Figs. 55 and 56 (G.-p. 39).—Rod-shaped bodies free in plasma—? bacteria.

Fig. 57 (G.-p. 39).—Leishman-stained cell, showing ring-shaped blue body with bright red granule.

Fig. 58 (G.-p. 49).—Similar to 31.

Fig. 59 (G.-p. 70).—Blue body without granule.

Fig. 60 (G.-p. 92).—Similar to Fig. 59.



. S. Harvey pinx.

Plate XIX

Figures painted from Giemsa and Leishman stained blood films of guinea-pigs inoculated with blood of normal guinea-pigs.

Figs. 61 and 62 (G.-p. 3*a*).—Deeply-stained bodies with dark chromatin granules.

Fig. 63 (G.-p. 3).—Chromatin ring with blue centre.

Fig. 64 (G.-p. 3).—Long rod-shaped blue body with chromatin granule in centre.

Fig. 65 (G.-p. 3).—Similar to Figs. 61 and 62.

Figs. 66 and 67 (G.-p. 3).—Free bodies in plasma.

Fig. 68 (G.-p. 3).—Blue body in touch preparation from spleen.

Fig. 69 (G.-p. 4*a*).—Ring-shaped chromatin granule with minute blue body.

Figures painted from blood films and touch preparations of organs of guinea-pigs inoculated from West African ' infected ' guinea-pigs.

Fig. 70 (G.-p. 62).—*Leishmania*-like body free in plasma.

Fig. 71 (G.-p. 63).—Giemsa-stained red cell with dark blue body and granule.

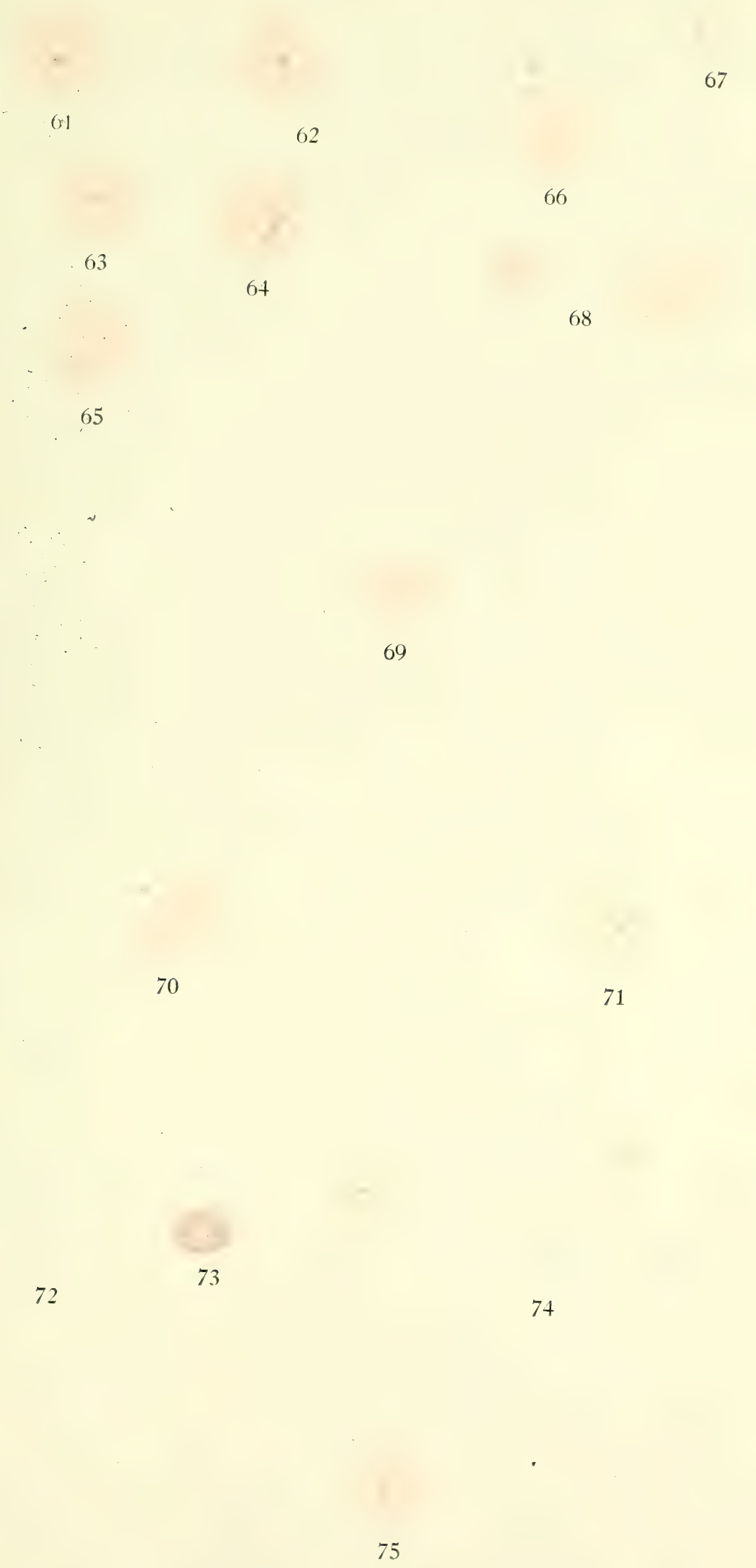
Fig. 72 (G.-p. 70).—Small blue rod with chromatin dots in red cell. Touch preparation from spleen.

Fig. 73 (G.-p. 70).—Small blue body in protoplasm of white cell. Touch preparation from spleen.

Fig. 74 (G.-p. 70).—Free ' blue bodies.' Touch preparation from spleen.

Fig. 75 (G.-p. 105).—Small blue body with chromatin granule in red cell.

PLATE XIX.



D. S. Harvey pinx.

YELLOW FEVER COMMISSION
(WEST AFRICA)

INVESTIGATORS' REPORT.

YELLOW FEVER COMMISSION

(WEST AFRICA)

REPORTS

ON QUESTIONS CONNECTED WITH THE

INVESTIGATION OF NON-MALARIAL FEVERS IN WEST AFRICA

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TABLE OF CONTENTS

REPORT OF THE ENTOMOLOGICAL INVESTIGATION UNDERTAKEN FOR THE COMMISSION FOR THE YEAR, AUGUST, 1914, to JULY, 1915.

BY

A. W. BACOT, F.E.S.

(*Entomologist to the Lister Institute of Preventive Medicine*).

LIST OF CHARTS OF TEMPERATURE AND HUMIDITY.

Weekly or monthly averages of daily readings, with minimum Humidity records in each week.

LIST OF FIGURES

LIST OF PLATES

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I.—INTRODUCTION.

The work with which this Report deals was carried out at Freetown, Sierra Leone, between the months of August, 1914, and August, 1915. A few experiments, for which there were no suitable facilities at Freetown, were performed at the Lister Institute of Preventive Medicine during October, 1915, with material resulting from eggs brought home from West Africa.

The original scheme of work in connection with the incidence of Yellow Fever in West Africa had to be largely modified owing to the outbreak of War. In the absence of clinical and pathological workers to co-operate with, the greater part of the energies of the entomological section were devoted to the elucidation of questions concerning the bionomics of *Stegomyia fasciata*, the main endeavour being to supplement and substantiate the already very considerable knowledge of the life history of this species, which we owe to Finlay, Goeldi, Reed and Carrol, Boyce, Newstead, Dupree and the members of the French Committee, as well as numerous other workers.

Time did not permit of the investigation of problems connected with the possibility of a seasonal variability. For instance, the tendency of eggs sometimes to hatch immediately they are placed in water, and at others to defer hatching for an indefinite period ; or, again, the question of the period for which different batches of eggs remain viable, may be associated with the season of the year in which the parents producing the eggs are reared, but to clear up these and similar points would necessitate the continuance of the research over several seasons.

Charts of the temperature and humidity records in the various places where experimental work was carried out will be found in the

section dealing with the length of the adult life (pages 64 and 92-101). Owing to delays in despatch and transit the thermometers were not available during the earlier months of the research. In order to give some idea of the conditions during the months of August, September, October and November, a summary of the general meteorological observations in Freetown for the year 1914 is included. The temperature of the water used for egg hatching and larvæ breeding would be, unless stated to the contrary, about 80° F.

It is with much pleasure that I avail myself of this opportunity of expressing my thanks to the members of the West African Medical Staff for their kindness in endeavouring to make my tour as pleasant and effective as possible; to Dr. W. Allan and Dr. J. S. Pearson and other friends, for placing at my disposal collections of mosquito larvæ taken in Freetown, and especially to Dr. G. G. Butler, who, in spite of the exceptional pressure of official work, brought me many collections of larvæ that he had made in the district surrounding Hill Station.

From the material collected and bred at Freetown sets of specimens of the prevalent species of mosquitoes were forwarded to the Liverpool and London Schools of Tropical Medicine, and to Mr. F. W. Edwards, of the British Museum of Natural History a small collection of specimens which it seemed possible might be of service to the National Collection. Amongst this latter material was a new species of *Eretmopodites*, of which Mr. Edwards is publishing a description in the "Bulletin of Entomological Research," Vol. VI., Part 4, page 362.

I take this opportunity of acknowledging my indebtedness to Mr. Edwards' (1912) "Keys of the African *Culicidæ* other than *Anopheles*," which I found of great assistance, and my thanks are due to their author for his kindness in checking and confirming my determinations.

My thanks and acknowledgments are also due to Messrs. Bruce F. Cummings, W. L. Distant, Stanley Hirst, G. Meade Waldo, D. J. Scourfield and H. M. Woodcock, for assistance in identifying species dealt with in this Report.

II.—INTRODUCTORY NOTES ON THE DISTRIBUTION OF MOSQUITOES IN FREETOWN (SIERRA LEONE) AND ITS VICINITY.

Mosquitoes are so far from being the omnipresent nuisance in Freetown that one is led to expect in the Tropics generally, and on the West Coast of Africa in particular, that there is a danger of being lured into a false sense of security leading to the lapse of all precautions.

Their apparent absence and actual rarity are partly due to the natural advantages conferred by the porous nature and contour of the soil, and largely to the efficiency and activity of the Sanitary Department in the inspection of compounds and the destruction of larvæ. The evidence afforded by a mosquito hunt beginning in the central area of the town and extending beyond its bounds is eloquent in its testimony of what has been accomplished.

In the outlying areas of the town and the adjacent villages much remains to be done, especially in the matter of the efficient drainage of surface water.

General observation and search for adults lead to the conclusion that *Culiciomyia nebulosa* is the dominant species within the central area, but if the larval stages be included in the search, and the larval collections made by the Sanitary Department are taken into consideration, it soon becomes obvious that an adult census is but a poor guide to the actual facts.

As regards breeding and general distribution the species of *Stegomyia*, especially *fasciata*, easily lead. Any relaxation of the Sanitary Administration in the matter of mosquito work would inevitably be accompanied by a rapid increase in the adult *Stegomyia* population.

It is even now an open question if adults of *C. nebulosa* are really more numerous than those of *S. fasciata*. While the former is comparatively casual in its selection of resting places—any damp or shaded wall in an outbuilding will do, and its breeding habits tend to produce sudden and very noticeable outbursts of adults—*S. fasciata* is exceedingly careful and able in hiding away, while it begets larvæ with a steady persistency in any available breeding place without a sign of an adult being seen.

The *Anopheles* species, *Pyretophorus costalis* and *Myzomyia funestus*, are much more restricted in distribution and breeding grounds, although the places affected by the last-named are of large extent where they do occur. Larvæ of *P. costalis*, though common and generally distributed in rock and gutter pools, are few in number compared with the swarms of *S. sugens* larvæ which are present in these situations in the outlying districts of the town (*see* Plates 8, 10 and 11, pp. 12 and 13). They also occur not infrequently within its central area, and are sometimes met with in tins and even in water-holes in trees. *M. funestus* is restricted in its breeding places and is only occasionally present in isolated rock pools, its regular *habitat* being the shallow hard-bottomed swamps which occur on the laterite flats at the foot of the hills, both to the east and west of Freetown (*see* Plates 13, 14 and 15, pp. 14 and 16). During the rains the surface water flows slowly out from the foot of the hills across these flats, covering wide areas with water trickling through the roots of the grass and forming shallow pools at frequent intervals. The pools are often tenanted by tadpoles, the mosquito larvæ being chiefly found among the roots of the grasses—the frogs or toads with which these swamps abound being no doubt responsible for the absence of mosquito larvæ in the open pools. The surface water cut between Alligator River and Congo River to the south of the railway has benefited the western end of the town by drying a considerable area of the flats and thus restricting the possible breeding grounds of *M. funestus*. On the east, however, above Fourah Bay and along the rail to Kissy large tracts of these flats are still in their natural condition.

Holes in trees, a favourite breeding situation with several species of *Stegomyia* and *Ochlerotatus*, have received special attention in the past, so that it requires careful search to find any within the central area of the town (*see* Plates 1 and 2, page 6). Small rock pools are however, only too plentiful in its outer areas, and these, together with old and irregularly graded road side drains, constitute possible breeding places, which must be a constant source of anxiety to the sanitary authorities, pending the extension of the admirably designed newer drainage system to the outer districts of the town (*see* Plates 4, 5 and 8, pp. 8, 9 and 12). Tins, jars, bottles, tubs, etc., would still seem to be the chief strongholds of *S. fasciata;* fortunately, as indicated above, the vigilance of the compound inspections prevents more than a tithe of the larvæ reaching maturity.

Plants.—The axils and central whorl of leaves of a number of plants provide breeding accommodation for a certain number of species during the rains. Of these, *Uranotænia ornatus* and a new species of *Eretmopodites** seem to be restricted to the water in these plant reservoirs. *Stegomyia simpsoni*, though most commonly reared from collections of larvæ taken from plants, certainly breeds in root holes also, while a few ubiquitous species, such as *Stegomyia fasciata* and *Culiciomyia nebulosa*, are occasional tenants.

The breeding of mosquitoes in plants opens up a difficult problem, as two of the plants, the banana and cocoa yam, are valuable sources of food supply, while another, the "Cock Hat" tree, a species of *Dracæna*, is a serviceable and largely used hedging plant. There are two species of this plant grown in Freetown and its vicinity, only one of which accumulates water in the central whorl and axils of its leaves ; both species are used for hedging, but the water holder much more frequently than the other. Possibly there may be some advantage, such as speed of growth, but unless this is weighty it would be well to discourage its use (*see* Plates 16 and 17, page 17).

The feeding tendencies of the specimens reared from larvæ taken in these plants were tested in regard to their willingness to suck human blood. The abilities in this direction of *S. fasciata* or *G. nebulosa* (occasionally present) need no comment. *S. simpsoni* was found to be as insatiable as *fasciata*. *Eretmopodites* would feed lustily, but only at long and irregular intervals. *Uranotænia ornatus*, bred only from these situations, invariably refused to bite or feed at all, although offered both honey and syrup.

---

* Described by Mr. F. W. Edwards in the "Bull. of Entom. Research" under the name *dracænæ*.

Plate No. 1.
Roots of a Cottonwood tree. Tower Hill.

Plate No. 2.
Waterhole in the roots of the same tree. Larvæ of *Stegomyia fasciata*, *S. simpsoni*, *S. luteocephala*, *Ochlerotatus minutus*, *O. apicoannulatus*, *Culiciomyia nebulosa* and *Anopheles costalis* were taken from this pool.

LIST OF MOSQUITOES IDENTIFIED FROM VARIOUS LOCALITIES, MOSTLY BRED FROM LARVÆ.

Central Area of Town.

Tower Hill.

Larvæ from water holes in cottonwood tree (*see* Plates Nos. 1, 2 and 3, pp. 6 and 8):—

Anopheles (*Pyretophorus*) *costalis*, Lw. ...	... two specimens.
Stegomyia fasciata, F.	... in numbers.
,, *simpsoni*, Theo.	... in numbers.
,, *luteocephala*, Newst.	... in numbers.
Ochlerotatus apicoannulatus, Edw. ...	... in numbers.
,, *minutus*, Theo.	... a few.
Culiciomyia nebulosa, Theo.	... a few.
Culex decens, Theo.	... in numbers during November.

Larvæ from rock pools (*see* Plates Nos. 4, 5 and 6, pp. 8 and 9):—

Stegomyia sugens, Wied.	... swarms.
,, *fasciata*, F.	... several.
,, *luteocephala*, Newst.	... one specimen.

Compound at Colonial Hospital.

Larvæ in old tins and broken bottles :—

Stegomyia fasciata, F.	... numbers.
Culiciomyia nebulosa, Theo.	... numbers.

Yard, 26, Westmoreland Street.

Larvæ in tins, bowls, etc. :—

Stegomyia fasciata, F.	... numbers.
Culiciomyia nebulosa, Theo.	... two or three broods.
Eretmopodites quinquevittatus, Theo. ...	... several.

Gloucester Road.

Surface water drain :—

Anopheles (*Pyretophorus*) *costalis*, Lw. ...	... one specimen.

Circular Road.

Surface water drain :—

Anopheles (*Pyretophorus*) *costalis*, Lw. ...	... one specimen.

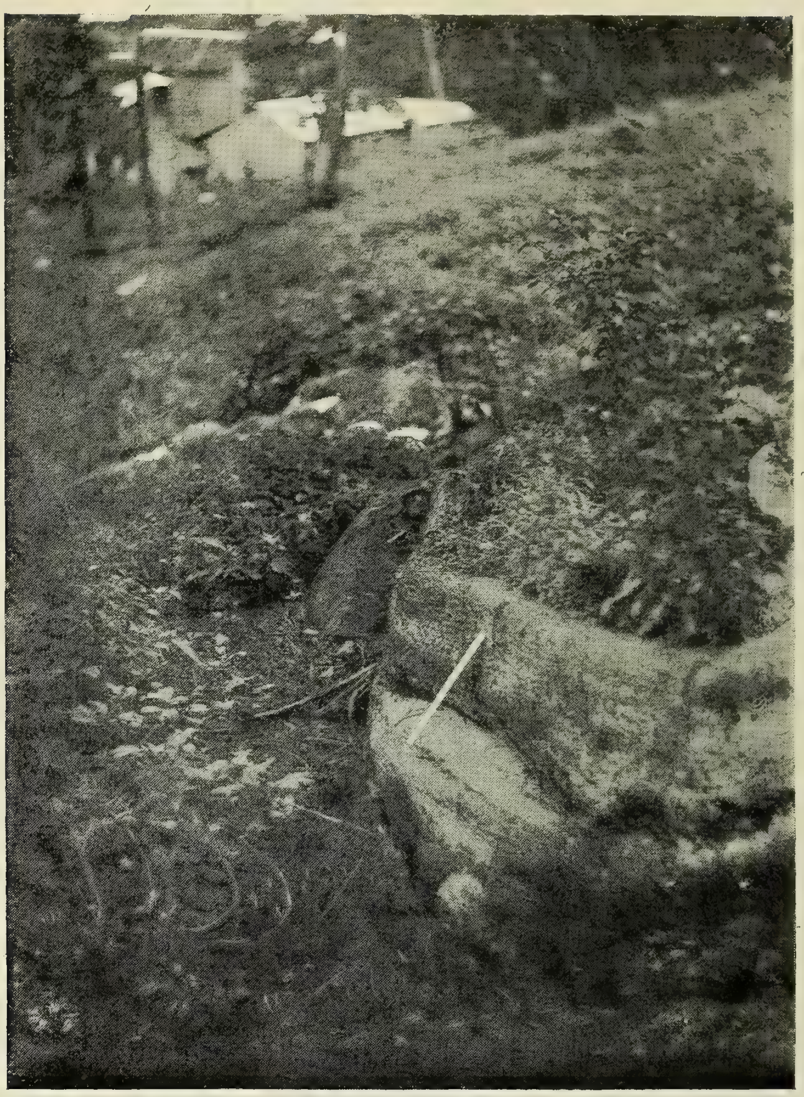

Plate No. 3.
The root hole in Cottonwood tree filled with cement.

Plate No. 4.
Rock Pool which contained larvæ of *Stegomyia sugens*. Tower Hill.
The white streak is a foot rule.

MOSQUITO BREEDING POOLS.

Plate No. 5.
Rock Pool which contained larvæ of *Stegomyia sugens*, *S. fasciata*, *and S. luteocephala*. Tower Hill.

Plate No. 6.
The same pool filled with cement.

Collections of Larvæ received from various Houses and Compounds in the central area of the Town, including the Rest House and Nursing Home.

Stegomyia fasciata, F. ... ... numerous.
Culex tigripes, Grp. ... ... two or three.
Culiciomyia nebulosa, Theo. ... ... numerous.

Campbell Street.

A tin from a compound :—

Megarhinus (*Toxorhynchites*) *brevipalpis*, Theo. one specimen.
Ochlerotatus apicoannulatus, Edw. ... ... several specimens.
Stegomyia frazeri, Edw. ... ... one specimen.

Post hole near Saunders Brook.

Stegomyia sugens, Wied. ... ... numbers.

Hill Station.

Rock pools :—

Anopheles (*Myzomyia*) *funestus*, Giles ... ... two or three.
Stegomyia sugens, Wied. ... ... numbers.
Ochlerotatus minutus, Theo. ... ... swarms.
,, *simulans*, Cart. ... ... one specimen.

Water hole in a tree :—

Stegomyia frazeri, Edw. ... ... one specimen.
Ochlerotatus minutus, Theo. ... ... numbers.

Lumley Road.

Bolt holes in cement foundation of sand elevator :—

Stegomyia sugens, Wied. ... ... numbers.
Culiciomyia nebulosa, Theo. ... ... numbers.

Wilberforce.

Old bottle, wayside ditch :—

Stegomyia fasciata, F. ... ... numbers.

Old tins, rubbish heap :—

Ochlerotatus minutus, Theo. ... ... numbers.
Eretmopodites quinquevittatus, Theo. ... ... several.
,, *chrysogaster*, Grah. ... ... a few.
,, *inornatus*, Newst.... ... ... one specimen.

Rock pools on wayside boulders (*see* Plate No. 7, page 11) :—

Anopheles (pyretophorus) costalis, Lw. ... ... one or two.
Stegomyia sugens, Wied ... ... numbers.
,, *luteocephalus*, Newt. ... ... a few.

ROCK POOL NEAR WILBERFORCE STATION.

Plate No. 7.

A breeding hole on a boulder on Wilberforce Hill; larvæ of *Stegomyia sugens*, *S. luteocephala* and *Anopheles costalis* were taken here. The white streak is a foot rule measure showing the small size of the hole.

Murray Town

Road side rock pools :—

Anopheles (pyretophorus) costalis, Lw. ...	... several.
Stegomyia sugens, Wied.	... numbers.
,, *fasciata*, F.	... numbers.

Cline Town.

Small tank in a compound :—

Anopheles (pyretophorus) costalis, Lw. ...	... several.
Culex tigripes, Grp.	... one or two.
Ochlerotatus apicoannulatus, Edw. ...	... a few.

MOSQUITO BREEDING POOL.

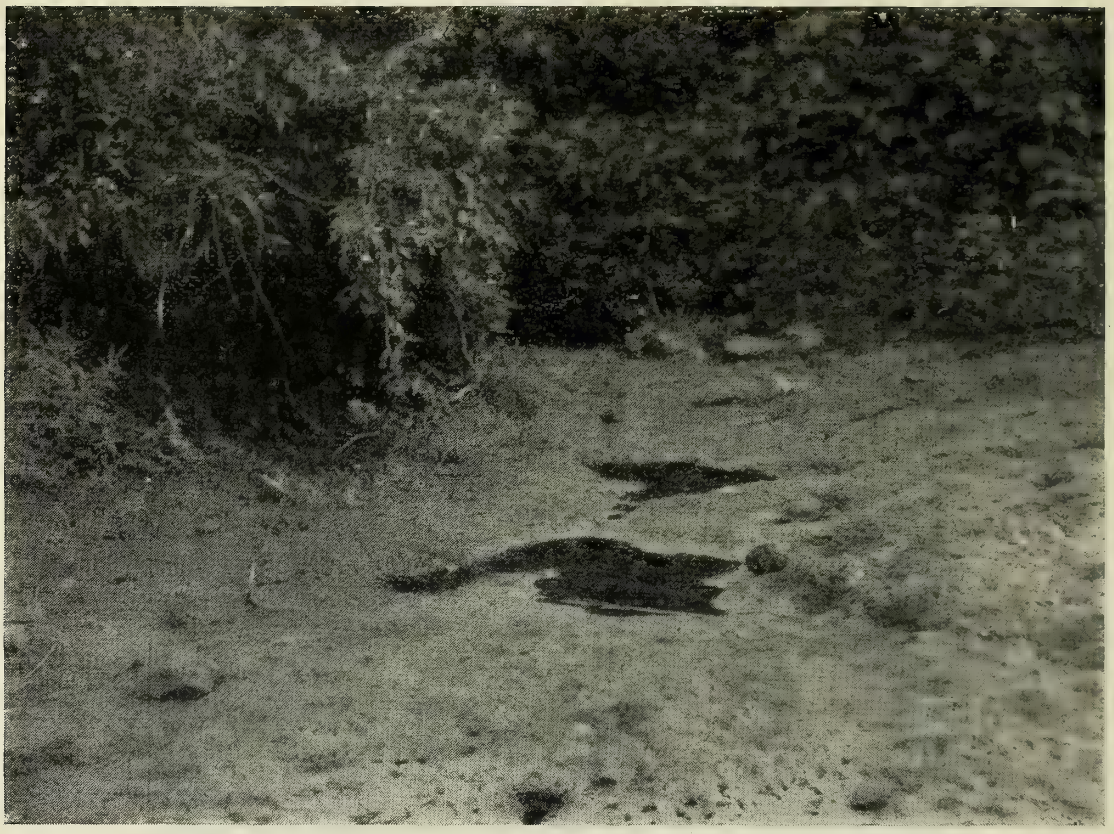

Plate No. 8.

Pools of water in bed of surface water drainage channel near Kissy Road Cemetery; contained larvæ of *Stegomyia sugens* and *Anopheles costalis* in May. In July this channel was the bed of a torrential brook.

BREEDING GROUND OF *ANOPHELES* MOSQUITOES.

Plate No. 9.

Swampy flats between Kissy Road and Fourah Bay. Suitable breeding ground for *Anopheles* mosquitoes. Washing in progress in the distance.

BREEDING GROUNDS OF *ANOPHELES* MOSQUITOES.

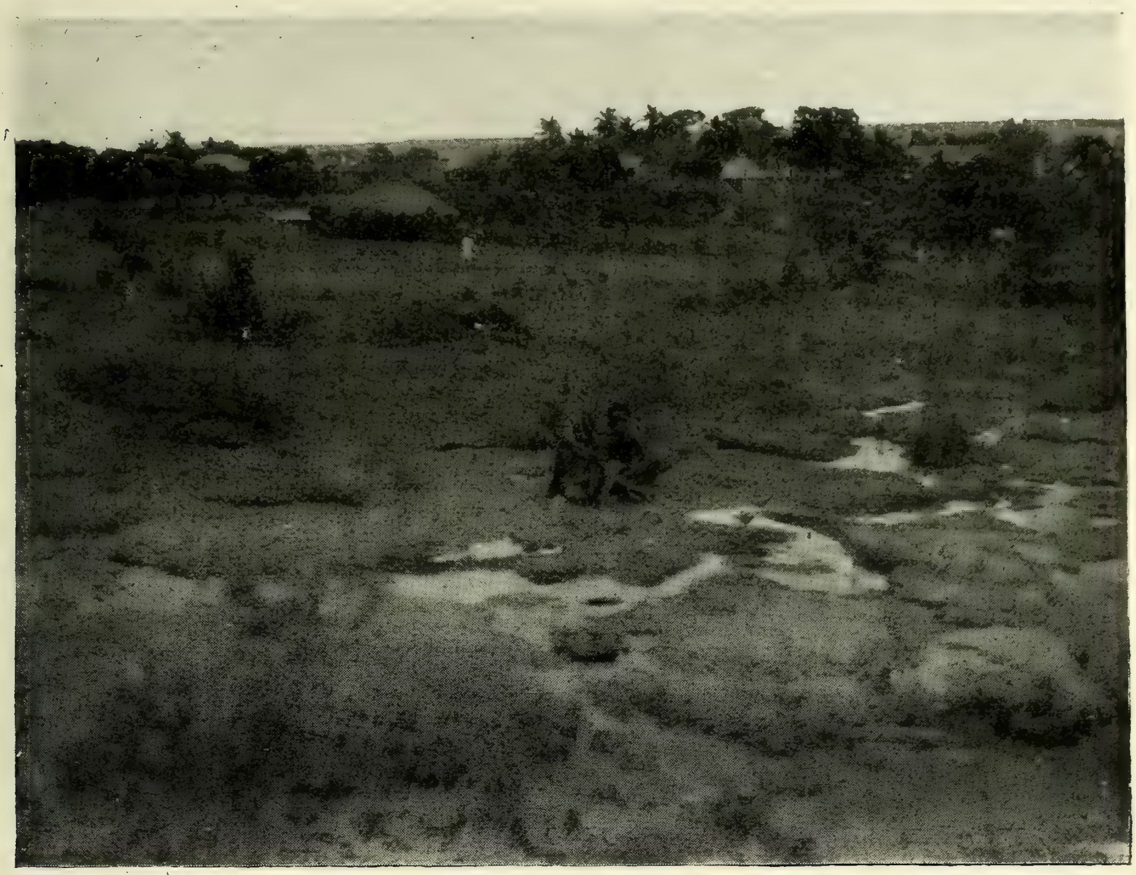

Plate No. 10.

Rock Pools on these flats ; *Anopheles costalis* and *Stegomyia sugens* were breeding here.

Plate No. 11.

Another view of the rock pools on the flats between Kissy Road and Fourah Bay.

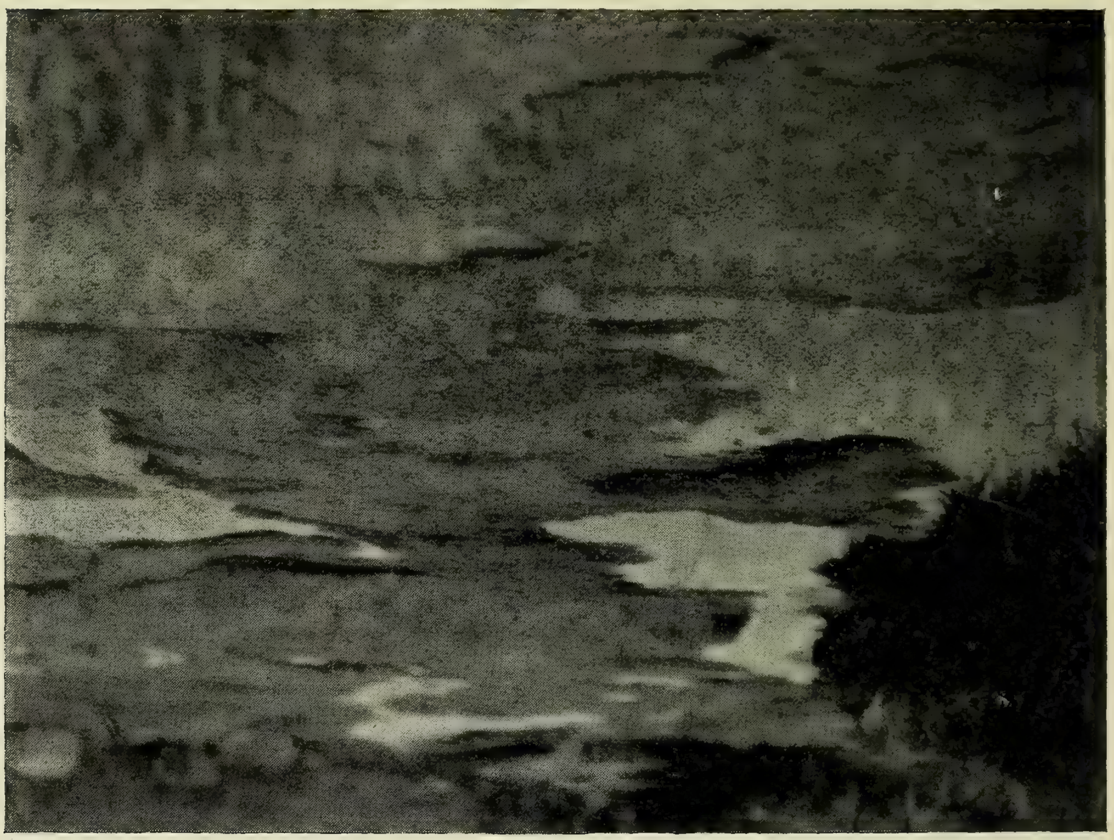

Plate No. 12.
Details of the rock pools shown in Plate 10. Contained larvæ of *Stegomyia sugens* and *Anopheles costalis.*

Plate No. 13.
View of Kissy flats, near the Station. Breeding grounds of *Anopheles funestus.*

Kissy Road.

Rock pools in wayside gutter near the cemetery (*see* Plate No. 8, page 12) :—

Anopheles (Pyretophorus) costalis, Lw. ... ... several.
Stegomyia sugens, Wied. ... ... numbers.

Flats between Kissy Road and Fourah Bay (*see* Plates Nos. 9, 10, 11 and 12, pp. 12-14) :—

Rock pools in shallow running swamp :—

Anopheles (Pyretophorus) costalis, Lw. ... ... numbers.
and probably *Myzomyia funestus*, Giles ... larvæ not reared.
Stegomyia sugens, Wied. ... ... swarms.

Kissy.

Rock pools in swampy lane :—

Anopheles (Pyretophorus) costalis, Lw. ... ... numbers.
Stegomyia sugens, Wied. ... ... swarms.

Pools in gutter by side of railway track :—

Anopheles (Pyretophorus) costalis, Lw. ... ... numbers.
Stegomyia sugens, Wied. ... ... swarms.

Shallow hard bottomed running swamps (*see* Plates Nos. 13, 14 and 15, pp. 14 and 16) :—

Anopheles (Myzomyia) funestus, Giles. ... ... larvæ captured in twos and threes over large areas.

The following species were reared from larvæ taken from plants in different parts of Freetown :—

Cocoa Yam.

Stegomyia simpsoni, Theo. ... ... common.
,, *fasciata*, F. ... ... a few.
Culiciomyia nebulosa, Theo. ... ... occasionally. When present, usually in numbers.
Uranotænia ornata, Theo. ... ... common.
Eretmopodites dracænæ, Edw. ... ... a few.

"*Cock Hat*" *Tree* (*see* Plates Nos. 16 and 17, page 17) :—

All the above species with the exception of *S. fasciata.*

Eretmopodites dracænæ, Edw. ... ... very common.

Banana.

Stegomyia simpsoni, Theo. ... ... not numerous.

Sarsaparilla.

Stegomyia fasciata, F. ... ... in numbers.
Eretmopodites dracænæ, Edw. ... ... a few.

Plate No. 14.
Another view; Kissy Village in the distance.

Plate No. 15.
Pools in the trickling swamps at Kissy Flats.

A PLANT WHICH AFFORDS BREEDING PLACES FOR MOSQUITOES.

Plate No. 16.

"Cock Hat" Trees ; a species of *Dracæna*. The species in the foreground collects water in the central whorl and axils of the leaves. The stiffer leaved variety in the background holds no water.

Plate No. 17.

"Cock Hat" Tree. Affords breeding place for *Stegomyia simpsoni*, *Uranotænia ornatus* and *Eretmopodites dracænæ*. *Stegomyia fasciata* and *Culiciomyia nebulosa* are also occasional breeders in this and other plants.

III.—BIONOMICS OF *S. FASCIATA.*

(*A*) EGGS.

General Notes.

The eggs of *Stegomyia fasciata* are small black spindle-shaped objects, which, as has been so frequently pointed out, are laid singly. They vary very considerably in size and shape, so that it is possible to pick out examples which in form and size closely approximate to the eggs of *S. sugens*, *S. simpsoni* or *S. luteocephala*, all of which differ from each other and, so far as the limited number of eggs of these species obtained is concerned, do not vary greatly individually in either size or outline. A noticeable feature of typical eggs of *S. fasciata* is that in one of their aspects they are slightly asymetrical, bow-shaped in outline, one side being flatter than the other.

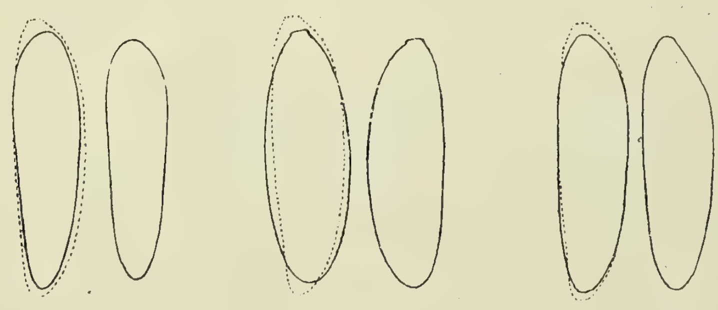

FIG. I.

Outlines of the eggs of *S. simpsoni*, *S. sugens*, and *S. luteocephala*, showing the difference in shape and size between the eggs of these species, and an average egg of *S. fasciata*. The dotted outline is that of the egg of *S. fasciata*.

Size.—The measurements of the normal eggs of *S. fasciata* are about ·630 to ·650 mm. in length and ·160 mm. at the greatest diameter. Small eggs, frequently of stumpy form, are sometimes laid of scarcely more than two-thirds the normal size, while large eggs, measuring up to ·8 or ·9 mm. long and proportionately thick, are occasionally to be found. The diminutive eggs are generally, though not always, laid in batches by females all of whose eggs are small, and they frequently either do not hatch at all or show a high

percentage of infertility. The giant eggs, on the other hand, are never laid in batches, but occur in twos and threes among eggs of more normal size and usually hatch. Pale, colourless, presumably immature eggs are occasionally found in batches of eggs which are of the normal colouration—these appear to be invariably infertile. Normally, however, all the eggs laid are either already dark when deposited or darken with great rapidity. The egg masses within the ovaries of the mosquitoes are usually colourless, but in many instances the ovaries of dissected mosquitoes were found to be already pigmented, usually of a bright brown. In England the number of white eggs seen after deposition suggests either that eggs were laid when less matured, or that the development of pigmentation is in some cases much less rapid, possibly owing to the lower temperature.

Surface Sculpturing.—The surface of the egg is covered with a delicate cellular reticulation formed by thin walls of chitin. From the centre of each cell space over the greater portion of the area arise hemispherical bosses. At the blunt end the cellular reticulation is produced to form a low wall surrounding the micropylar area of the egg.

The Bosses.—The bosses within the cell walls are not merely structural irregularities of the egg wall, but are definite masses of a stainable substance, probably of a colloidial nature. Sections of the eggs within the ovary show that these bosses are apparently formed in pockets of a delicate inner membrane which enshrouds the egg.

The purpose of the structural features of the eggs of *Stegomyia* is usually assumed to be connected with the floating of the eggs, which are heavier than water and sink once they are freed from the surface film of water. In view, however, of the fact that surface structure of the shell alone would be quite sufficient, as in the case of other insect structures, to meet all the requirements connected with adjustment to the surface film, it seems not improbable that the bosses may serve an entirely different purpose to the cellular reticulation with which they are associated. This purpose may possibly be connected with the insulation of the egg from heated surfaces on which it rests, or, as seems more probable, with the ability of the eggs to resist desiccation.

In this connection it may be noticed that shrunken eggs, the sides of which are collapsing, often contain living larvæ, and, further, that such eggs will regain their full rotundity when placed in

water, while after regaining their original shape they may still defer hatching to a later period. The suggestion is that by means of these bosses the egg is enabled to absorb moisture if wetted by rain or dew.

Situation where eggs are laid.—The eggs of *Stegomyia* are generally stated to be laid on the surface of the water. This may very possibly be accurate in the strict sense of the word, in that there is always a film of water present on which the egg is laid. Certainly no instance of an egg being laid on a dry surface has occurred with the thousands laid by captive females in the course of this research, and very few were ever laid in receptacles containing honey or syrup for the adults, even when there was no other liquid available for oviposition. As a general statement, however, it is misleading to say that the eggs are deposited on the surface of the water, as in the great majority of cases they are to be found on the wet margins of the receptacle containing the water, or of some partially submerged object, such as a leaf or twig. These situations suggest that they are either deposited on the margin itself—in some instances there was definite proof that such was the case—or on the water in such close proximity to the margin that capillary action on an evaporating surface inevitably strands the greater proportion of them.

The general position during oviposition would seem to be for the female to rest on the margin with her back to the water. In certain instances, however, the eggs are widely scattered over the water surface suggesting that they are deposited while the female walks on the water. All the evidence from the laying of eggs on wet filter paper points to the fact that they are deposited while she rambles about. It may be mentioned while dealing with this point that the eggs appear to hatch equally well whether resting at the bottom, floating, or attached to the margin beneath the surfare. Only a single instance of a female laying her eggs in a cluster on the surface of water was observed. In this case the female had thrust one or more of her legs through the surface film and was found lying on her side in a bogged condition alongside her eggs. The laying of eggs in clusters would seem to be of rare occurrence.

A few eggs, presumably only a small proportion of those laid on the water surface at its margin, sink at once. Others that have been laid or stranded on the steep or vertical sides of breeding pans are washed down, some sinking, while the remainder are restranded.

No doubt under natural conditions, where the range of circumstances is less restricted, the figures may be less one sided, but with

PHOTOGRAPHS OF EGGS OF *STEGOMYIA FASCIATA.*

Photo by F. Noad Clark.]

Plate No. 18.

Eggs of *Stegomyia fasciata*, laid on leaf of Cottonwood tree. × 20.

Photo by F. Noad Clark.]

Plate No. 19.

Egg of *Stegomyia fasciata*, laid on leaf of Cottonwood tree. × 40.

the methods adopted for rearing in this research by far the larger proportion of the eggs deposited were either laid, or stranded by capillary action, on the filter paper covering sides of the breeding pans above water level, at an estimate quite 90 to 95 per cent. Even with such badly adapted margins for stranding as tins would appear to afford, rust and dirt quickly produce an absorbent surface which acts almost as well as filter paper for the attachment or stranding of eggs.

Distribution after laying.—Eggs laid in the hollows formed in the beds of small streams, ditches, runlets, or guttering will tend to be washed downwards with each successive shower of rain and collect in the larger and more permanent pools, cisterns or water butts, as the case may be, as the attachment of the eggs is precarious in the absence of any other cement than that afforded by water scum, which, though firm enough during dry weather, is easily soluble in rain water. Eggs laid in sheltered water holes, in tree trunks, rock pools or tins are less liable to be distributed, but even in these cases a certain number will be laid on fallen leaves, some of which may be scattered during dry periods. With undisturbed eggs the gradual rise of water level during the onset of rain affords ideal conditions to induce hatching by gradually wetting and then immersing them in cool water, while at the same time the number of larvæ hatching tends to be automatically adjusted to the quantity of water.

Hatching.—The egg shell is ruptured by a clean transverse break at about a quarter of its length from the blunt micropylar end. Sometimes the cap falls completely off, but more frequently it is left slightly attached to or lying against the shell like a hinged lid. As the level of this clean cut corresponds with the position of the egg breaker, or more properly cutter, on the head of the larva, there can be little doubt as to the origin of the rupture in the shell which allows the larva to emerge. There are, however, some minor points connected with hatching which would seem to suggest automatic action on the part of the egg case and its contents apart from voluntary movement of the larva at the moment of its emergence.

In a number of cases eggs which had undergone long periods of dry storage, or had been submitted after long resistance of other methods to cooling, hatched, but yielded larvæ so feeble that they speedily died.

Eggs hatched under the influence of salt water show a considerable proportion which uncap although the larvæ do not emerge*. Again

* This also occurred to eggs that had been exposed to Formaline vapour for 24 hours.

there is the existence of what may be termed a time zone system in the hatching of resistant eggs. They do not respond to the repetition of *stimuli* at short intervals in the same marked manner that they show if the repetition occurs after a considerable lapse of time. And further, as will be shown later in Experiment No. XVIII., there is evidence that the latent tendency to defer hatching, which is probably hereditary, may be considerably influenced by external conditions after incubation.

In the light of these considerations it seems possible that the larvæ, which appear to be fully developed within 40 hours of the laying of the egg*, differentiate as regards the period when they perform the operation of incising the shell, those that have already performed this operation being ready to respond to external *stimuli* at once, while the others must delay until the necessary action is performed or defer indefinitely because the conditions have ceased to stimulate before the operation is completed.

It seems questionable to what extent volitional action on the part of the larva is responsible for the final uncapping of the egg. Sometimes the larva emerges with a "Jack-in-the-box"-like celerity, at others it will remain quiescent for a minute or so and then quickly and easily get free, or it may feebly and slowly struggle out.

Experimental Evidence Relating to the Hatching of Eggs.

The experimental evidence concerning the hatching of eggs is to a considerable degree bound up with questions of egg laying and fertility, which belong rather to the section dealing with adults. This is especially the case with the two preliminary Experiments, Nos. I. and II, which are included in this section, as they preface the whole of the experimental work dealing with hatching as well as that concerning egg production and fertilization ; the chief value of these provisional experiments being in regard to the questions raised during their progress and the basis thus afforded for planning better controlled tests.

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* In Freetown at a temperature of 80° F.

Experiment No. III.

HATCHING OF EGGS LAID BY A WILD FEMALE OF *STEGOMYIA FASCIATA*.

A living female was found "bogged" on the surface of the water contained in a biscuit tin (at 26, Westmoreland Street). Her feet had broken through the surface film, and in this trapped position she had laid a batch of 59 eggs. In the light of later experience, the position in which the eggs were laid and their arrangement was most unusual; at the time it was thought that this was a normal instance of egg laying. The eggs were taken up on a slip of filter paper and a camera drawing of the arrangement of the eggs as laid was prepared. The batch was carefully submerged in a glass dish containing 200 c.c. of tap water.

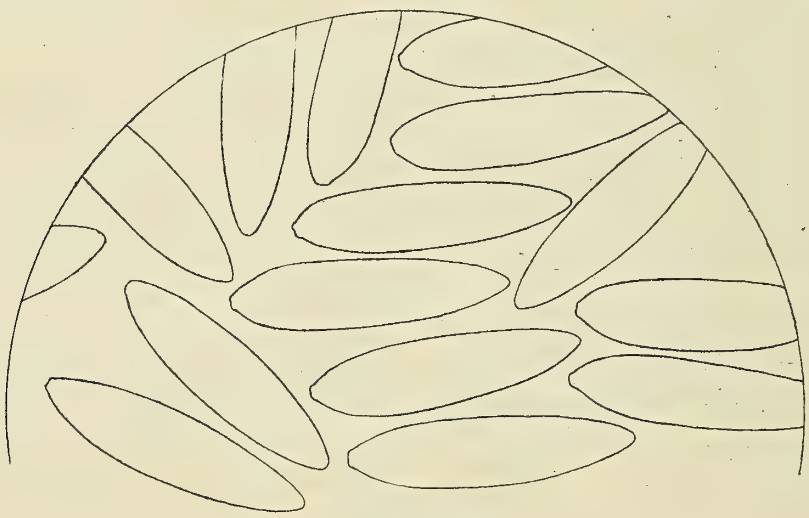

FIG. 2.

Date of laying.	Number of eggs.	Date of hatching.			
		September.		October.	
		27	28	5	12
24th September ...	59	35	3	**17**	**3**

Remarks and Notes.

The block figures indicate that hatching followed after a break in the continuity of the conditions.

On the 4th October the pan was refilled with fresh water, and on the 12th the eggs were lifted from the water for a space of four hours and allowed to dry; they were then re-immersed in the same water.

One egg remained unhatched; this was taken from the water on the 17th October, dried and then returned to the water. This was repeated on the 23rd October, and again for the fourth time a few days later. As the egg

Experiment No. I.

PRELIMINARY EXPERIMENT REGARDING THE LAYING AND HATCHING OF THE EGGS OF *STEGOMYIA FASCIATA*.

Two females and several males used.

The first female emerged 20th August, 1914; the second on the 1st September, 1914.*

The first male emerged 30th August, 1914; the second on the 4th September, 1914. Other males were placed with the females when these two died. Opportunities of feeding on human blood were afforded each night.

The eggs were collected each day from the wet filter paper on which the glass jar containing the mosquitoes was inverted.

All the eggs were submerged in water, none were allowed to remain floating.

Batches 1 to 9 were kept in separate glass dishes of various sizes, except the three laid on 12th, 13th and 14th September (*Nos.* 6, 7 and 8), these were in larger pans than the others and equal in size.

Batches 10 to 13 separated from each other in small glass dishes were all submerged in one large pan.

Batches 15 to 20 separated from each other in small glass dishes were all submerged in a second large pan.

Batches 21 to 30 kept in separate dishes.

†*Batch No.* 14. These 250 eggs, put down under date of the 22nd September, were collected from the rim of the jar. As no previous search for eggs had been made in this situation it is probable that this batch represented an accumulation covering several days. This situation was subsequently searched each day.

Dates on which eggs were laid.	Number laid.	Reference number.	Date of hatching. September. 14	15	16	17	18	19	20	21	22	23	25	26	27	28	29	30	October. 1	2	3	5	6	16	19	22	24	25
4 September ...	11	1	...	...	1	2	...	...	...	...	...	...	...	...	...	...	**7**	...	...	...	...	...	...	...	...	...	...	...
6 ,, ...	36	2	...	...	...	...	...	1	...	2	1	1	...	...	...	...	**5**	...	...	...	...	...	...	...	...	...	...	...
7 ,, ...	16	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
9 ,, ...	112	4	2	2	1	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
10 ,, ...	1	5	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
12 ,, ...	49	6	...	...	49	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
13 ,, ...	62	7	...	...	1	4	**22**	**11**	**1**	...	...	...	...	...	...	...	**2**	...	...	...	...	...	...	...	...	...	...	...
14 ,, ...	67	8	...	...	...	...	...	...	1	3	...	1	...	...	...	...	**2**	**1**	**1**	...	...	...	...	**1**	...	...	...	...
15 ,, ...	11	9	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
17 ,, ...	41	10	...	...	...	...	...	...	...	1	1	...	2	1	6	...	**3**	**1**	...	...	...	...	...	...	...	...	...	...
18 ,, ...	22	11	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	**1**	**2**	...	...	...	...	...	...	...	...
19 ,, ...	1	12	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
21 ,, ...	3	13	...	...	...	...	...	...	...	...	...	...	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
22 ,, ...	†250	14	...	...	...	...	...	...	...	...	...	...	65	8	...	...	...	...	...	...	...	...	1	...	...	...	...	...
22 ,, ...	33	15	...	...	...	...	...	...	...	...	...	...	1	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...
23 ,, ...	8	16	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...
24 ,, ...	86	17	...	...	...	...	...	...	...	...	...	...	...	...	6	74	1	...	...	...	...	...	...	...	...	**3**	...	...
26 ,, ...	12	18	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
27 ,, ...	8	19	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	5	...	...	...	...	...	...	...	...	...
28 ,, ...	83	20	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	5	24	6	...	...	...	**8**	**35**	...	...
30 ,, ...	1	21	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...
2 October ...	60	22	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	15	6	...	...	...	...	**20**	**1**
3 ,, ...	4	23	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	4	...	...	...	...	...	...
4 ,, ...	4	24	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
5 ,, ...	2	25	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
7 ,, ...	3	26	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
8 ,, ...	12	27	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
9 ,, ...	7	28	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
10 ,, ...	4	29	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
11 ,, ...	31	30	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	1,040																											

1. The remaining egg failed to hatch and collapsed on drying.
2. The remainder dried on 10th October; all but one collapsed, this egg was opened and found to contain a larva.
3. All failed to hatch during the month that they were kept in water and collapsed when dried.
4. The remainder collapsed when dried on 13th October.
5. Failed to hatch during the month it was kept in water and collapsed when dried.
6. For a whole batch of this size to hatch on the same day is very unusual.
7. The remainder collapsed when dried on 13th October.
8. When dried on 15th October all but one collapsed; this egg was returned to the water and hatched on the following day.
9. All collapsed when dried on 14th October.
10. The balance collapsed when dried on 14th October.
11. The remainder collapsed when dried on 14th October.
12. Collapsed before its removal from the water.
14. When dried on 25th October all the unhatched eggs except three collapsed. These three were returned to the water but failed to hatch; they were again dried on 9th November and immersed on January 15th, and failed to hatch, when dried for the third time they collapsed.
15. The remainder collapsed when dried on the 16th October.
16. The remainder collapsed when dried on the 18th October.
17. The remainder collapsed after the second drying on the 23rd October.
18. All collapsed when dried on the 16th October.
19. As the remaining eggs failed to hatch and did not collapse they were stored on the 9th November, 1914, but were dead when opened in May.
20. After the third drying all the unhatched eggs but one collapsed, this egg resisted altogether five dryings and re-immersions; it was stored dry from the 9th November until the 30th December, when it was found to have collapsed.
22. After the second drying there were 17 unhatched eggs which did not collapse. None of these hatched on the third immersion; they were dried and stored on the 9th November, 1914, but were dead when opened in May.

24 to 30. These batches were kept immersed for three weeks, they were then dried; all collapsed.

* One female escaped on the 2nd October, the other died on 13th October.

REMARKS AND NOTES.

Where the figures showing the number of eggs hatching are given in block type it is to be taken as an indication that the continuity of the conditions had been interrupted.

In the case of *Batch No. 7*, the eggs were shifted on the 17th September from a small to a larger pan filled with fresh water. On the 28th September the pans containing eggs of *Batches Nos. 1 to 5* and *6 to 10* were re-filled with fresh water. The 3 larvæ that hatched from eggs of *Batch No. 17* on 22nd October did so within 15 minutes of their re-immersion in water after a second drying; the first drying and re-immersion having failed in its object.

The response of *Batch No. 20*, with 8 larvæ hatching on the 19th and 35 on the 22nd October, was apparently due to drying and re-immersion on the 18th and 21st October respectively. In this instance also most of the larvæ were free from the eggshell within 10 minutes of their being placed in water.

With *Batch No. 22* the hatching of the 20 larvæ that emerged on the 24th and 1 on the 25th October was apparently due to the drying of this batch on the 23rd, and its re-immersion on the 24th. Here again the majority of the larvæ were out within 10 minutes of the eggs being returned to the water.

Experiment No. II.

EXPERIMENT REGARDING THE LAYING AND HATCHING OF EGGS BY *STEGOMYIA FASCIATA*, IN WHICH ONLY ONE FEMALE WAS USED.

The female emerged on the 10th September, 1914. Two males were kept with her; one emerged on the 11th September, and the other on the 13th September.
Opportunities for feeding on human blood were afforded each night from the 10th September onwards. The female died on the 27th October (life 47 days).
The eggs were collected each evening from the wet filter paper on which the glass jar containing the mosquitoes was inverted.
All the eggs were submerged in water. None were allowed to float.
Each batch when laid was placed in a solid watch glass and these were submerged in a large glass trough so that all the batches might have identical conditions in regard to quantity and temperature of water.

Date on which eggs were laid.	Number of eggs laid.	Reference number.	Date of hatching. September.							October.							November.				December.							
			20	21	24	26	27	28	29	1	2	18	19	20	21	23	1	2	21	22	2	3	4	16	20	24	28	29
16 September ...	8	1	1	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
17 ,, ...	10	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
20 ,, ...	16	3	...	...	1	1	...	...	...	...	...	...	11	1	...	...	...	...	...	...	...	...	...	1	...	...	...	...
24 ,, ...	32	4	...	...	...	3	...	1	4	...	...	...	...	...	...	1	10	...	2	...	...	...	...	...	...	...	...	...
24 ,, ...	*99	5	...	...	...	26	4	4	4	1	1	...	...	...	...	...	23	3	...	...	...	...	...	...	...	...	...	...
3 October ...	4	6	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
5 ,, ...	38	7	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	4	3	26	...	1	4	...	...
9 ,, ...	24	8	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
10 ,, ...	8	9	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
12 ,, ...	4	10	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	1	...	...
13 ,, ...	18	11	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	4	...	...	...	...	...	2	1
14 ,, ...	31	12	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2	...	...	1	2	1	...
18 ,, ...	17	13	...	...	...	...	...	...	...	...	...	...	...	...	1	6	...	...	...	10	...	...	...	...	...	...	...	...
19 ,, ...	16	14	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...
21 ,, ...	23	15	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2	...	...	1	...	...
Total ...	348																											

REMARKS AND NOTES.

The pan was refilled with fresh water on 6th October without any apparent effect.

1. The remaining eggs were accidently destroyed after removal from the pan on 17th October.
2. All collapsed when dried on 17th October.
3. Dried on 18th October, re-immersed on 19th, 10 hatched in 10 minutes, 1 later in the day, 1 the next day. Of the two remaining eggs, one collapsed after its third drying, while the other, after resisting five dryings and re-immersions, was stored dry from 9th November to 16th December. It was then immersed and hatched within 30 minutes, but the larva died before its first moult.
4. Dried on 20th October, re-immersed on 21st The balance dried for the second time on the 23rd, and for the third time on 25th, 14 eggs retained their shape unaltered after the third drying. When re-immersed on 1st November, 4 hatched in 20 minutes and 6 more within 2 hours. On the 2nd November, the batch was dried for the fourth time and was not re-immersed until the 12th. No eggs hatched and the batch remained in water until the 21st November, when the pan containing the eggs and water was put into an ice chest for an hour and a half; during this period the temperature of the water fell from 80° F. to 73° F. 2 eggs hatched; remaining eggs dissected on 12th May and found to be dead.
5. Dried on 23rd October; none hatched on re-immersion Dried again on 24th October, and not immersed until 1st November; 3 hatched within 15 minutes, 23 within 2 hours, and 3 more the following day. On the 3rd November the batch was dried for a third time and re-immersed on the 4th; none hatched Dried for the fourth time on 5th November, and again immersed without any eggs hatching. The batch was dried for the fifth time on 8th November and stored until the 10th January, when all the unhatched eggs were found to have collapsed.
6. All collapsed when dried on 22nd October.
7. Dried on 5th November and stored until 2nd December, when the eggs were put in a cool, heavy rain for about half an hour; they were then immersed in water; 4, 3 and 26 hatched on successive days. The batch was kept immersed until the 20th December, when the piece of filter paper on which the eggs were laid was lifted from the water and exposed to a very cool, dry wind that was blowing: the batch was again immersed while the eggs were still wet; 1 hatched within an hour, and the remainder on the 24th December when cooled in ice chest.
8. Immersed until 4th November, then dried and re-immersed; none hatched. They were again dried on 9th November and stored. Remaining eggs opened on 12th May and found to be dead.
9. Immersed until 4th November, then dried and re-immersed; none hatched. They were again dried on 9th November and stored. Remaining eggs opened on 12th May and found to be dead.
10. Immersed until 8th November, then dried and exposed to rain on 2nd December; 1 hatched. Cooled on 20th December, by lifting from the water and exposing to cool, dry wind; cooled in ice chest on 24th December: 1 hatched. A second cooling by dry wind action on 28th December without effect. Dried and stored 31st December; examined April, when the remaining eggs were found to be dead.
11. Immersed until 8th November, then dried; exposed to rain on 2nd December, 4 hatched. Cooled in dry wind on 20th December; none hatched when re-immersed. Again cooled in dry wind on 28th December. 2 hatched and 1 on following day. Remainder dried and stored 31st December; all unhatched eggs collapsed during 3 months' drying.
12. Immersed until 8th November, then dried, exposed to rain on 2nd December; 2 hatched on 3rd. Cooled in dry wind on 20th December, 1 hatched the same day and 2 when cooled in ice chest on the 24th. Again cooled in dry wind on 28th December, 1 hatched. Remainder dried and stored 31st December; examined 30th April, all unhatched eggs dead.
13. Immersed until 8th November, then dried and re-immersed 15th November; none hatched. On 21st November the pan of water containing the eggs was placed in an ice chest for an hour and a half; during this period the temperature fell from 80° F. to 73° F. All the remaining eggs hatched on the following day.
14. Immersed until 8th November, then dried and re-immersed; none hatched. On the 17th November an egg was opened and found to contain a fully formed larva to all appearances living, but it failed to make any movements when placed in water. Cooling in dry air on 20th December was without result, but after a repetition on 28th December 1 hatched. The remaining eggs were stored on 31st December. Remaining eggs opened 12th May and found to be dead.
15. Immersed until 8th November, then dried and re-immersed a week later; 2 hatched on 4th December (this was not a response to any break in the continuity of the conditions). Cooled in dry wind on 20th December; 1 hatched on 24th when cooled in ice chest. The second cooling in dry wind on the 28th December had no effect. Remaining eggs dried and stored on 31st December; examined 30th April, all unhatched eggs dead.

* The 99 eggs of Batch No. 5 put down under date of the 24th September, were collected from the rims of the jar; as no previous search for eggs had been made in this situation it is probable that this batch was an accumulation covering several days. This situation was subsequently searched for eggs each day.

did not hatch nor collapse, it was opened, and found to contain a fully developed larva in fresh condition, probably killed in the dissection of the egg.

Experiment No. IV.

EFFECTS OF EVAPORATION AND REPLACEMENT OF WATER.

A female that emerged 23rd–24th September was left for three or four days in a cage with a number of males and then segregated. Opportunities of feeding on human blood were afforded daily. The female died on 3rd Oct. Eggs were collected each day. All the eggs were submerged when in water. Very small pans were used, containing only 10 to 15 c.c. of water.

Dates on which eggs were laid.	Number of eggs laid.	Reference number.	Date of hatching. October. 3	6	7	12	21	November. 11
30th September ...	12	1	8	2	...	...	1	...
1st October ...	7	2	...	...	1	1	3	1

Remarks and Notes.

1. The water was allowed to evaporate; by the 20th October the eggs were dry. Fresh water was added, and 1 egg hatched in two hours and a half. The remaining egg collapsed while in water.

2. The water was allowed to evaporate; by the 20th October the eggs were dry and fresh water was added. 1 egg hatched within twenty minutes, 2 more within five hours. The water was again allowed to evaporate, by the 10th November the two remaining eggs were again dry; 1 collapsed, the other was re-immersed and hatched within thirty minutes.

Experiment No. I. is concerned with the laying and hatching of eggs laid by two bred females which had the companionship of several males during the course of their lives.

Experiment No. II. is concerned with the eggs laid by a single female, but two males were placed with her in order to better the chances of all the eggs laid being fertilized.

The plan of putting batches of eggs in small dishes and immersing them in one large pan of water was extended in this experiment to the whole series, with a view of getting the conditions for all the eggs as nearly identical as possible.

Experiment No. III. dealt with a batch of eggs laid by a wild female; the opportunity afforded by this find was seized on as a means of checking results obtained when eggs laid by reared captives

were used. As it turned out, the occasion was unique, but there is no reason to suppose that the eggs were in any way affected by the accident of their deposition.

Experiment No. IV. was initiated to contrast the effect of gradual evaporation of the water in which the eggs were submerged with the less natural methods employed to induce resistant eggs to hatch in Experiments No. I. and II.

The fact that 49 eggs forming batch 6 in Experiment No. I., which all hatched on the same day, were kept in a larger pan of water than batches 1 to 5 in the same experiment, raised the question of a possible relation between the size of the body of water and period of hatching.

The existence of such a relation was supported by the hatching of a large number of eggs of batch 7 (Experiment No. I.), following upon their transference to a larger dish of water. On the other hand, the addition of fresh water apart from any change in quantity was the apparent cause of batches 1, 2, 7, 8 and 10 hatching on the 29th September. A comparison with the hatching of eggs in Experiment No. II., when the quantity of water was much larger, and Experiment No. III., when it was equally large, pointed to the probability of the unanimous hatching of the eggs in batch 6 being a chance occurrence, while the partial nature of the response to either removal to larger pans or the renewal of water, together with the vagaries of hatching displayed by the batches immersed in the same pans of water in both Experiment No. I. and Experiment No. II., showed that the factors underlying hatching were probably of a complex nature.

The high percentage of apparently infertile eggs and the erratic nature of their distribution among the various batches of Experiment No. I. rendered it very doubtful if both the females had been fertilized.

It was an evident feature of all these early experiments that the incidence of hatching was dominated to a greater or lesser extent by external conditions, among which drying, the changing of water, and temperature conditions acted as *stimuli* on a certain proportion of the eggs only, wild laid eggs being affected as well as those laid in captivity.

The points raised which it seemed desirable to investigate further may be summarised in the following questions :—

(1) Does the quantity of water in which the eggs are immersed have any further influence on hatching ?

(2) Are all the eggs laid by a female capable of surviving drying; if a portion only, is the ability restricted to certain batches or evenly distributed?

(3) What is the effect on hatching of immediate as contrasted with deferred immersion; does the mortality rise in relation to the period of storage and is it affected by the humidity of the conditions of storage?

(4) Is temperature the stimulating factor which induces resistant eggs to hatch when dried and re-immersed, when they are transferred to fresh water, or when fresh water is added to that in which they are already immersed?

(5) For how long a period after impregnation is a female able to lay fertile eggs?

(6) How many females can a single male impregnate, and what percentage of the eggs of any one female will prove fertile after impregnation by a single male*?

To these may be added a question which practically belongs to this series, but was only formulated in response to results obtained in the conduct of the experimental work above outlined:—

(7) To what extent can resistance and the tendency to defer hatching be induced by external conditions after incubation?

In order to save time, owing to the probable death of some of the insects segregated for trial, most of the experiments were started in duplicate, and in some cases bulk experiments dealing with numbers of eggs laid in the general cages were performed dealing with the same or parallel points to support the results obtained when using single females.

It will be observed that information other than that directly aimed at was obtained in some cases; such by-products are commented on when dealing with the particular experiments involved.

The experiments dealing with Questions 1, 2, 3, 4 and 7 are included in this section, while those relating to 5 and 6 are placed in that dealing with the adults. An addendum to Experiment No. XLVI. (page 123), showing the detail of the number of eggs laid by one of the females and their dates of hatching, is included with the experiment to which it belongs in the adult section, although the evidence it affords is equally applicable to this.

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* The act of copulation is so rapidly and apparently frequently performed that it was not found practicable to limit the question to the result of a single pairing.

Experiment No. V.

EFFECT ON HATCHING OF SUBMERGENCE IN A SMALL OR LARGE QUANTITY OF WATER.

(*a*) Eggs Laid by a Single Female.

A female that emerged on 3rd or 4th of October was placed in a cage with a number of males. She was then segregated and afforded daily opportunities of feeding on human blood.

The eggs were collected daily and divided into two batches ; these were placed in small glass dishes, one of which was submerged in a pan containing 400 c.c. of water and the other in a pan containing 4,000 c.c.

The water used was rain water that had been exposed to air and sun for a week and then strained through fine gauze.

All the eggs were kept submerged until the 8th of January, when they were dried and the sound unhatched eggs returned to the water.

Female died 22nd October.

Date of laying.	Number laid.	Number in each lot.	Reference number.	Date of hatching.																														Mortality.
				October.																November.														
				10	11	12	13	15	17	18	19	21	25	26	27	28	29	30	31	1	3	7	9	10	12	14	18	20	22	23	24	25	30	
7 October	62	31 small	1	16	1	2	2	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	1	4	1	1	6 per cent.
		31 large	2	20	5	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	4	...	...	...	...	3 per cent.
14 „	48	24 small	3	...	...	...	...	...	1	4	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	4	14	...	...	...	...	Nil.
		24 large	4	...	...	...	...	...	3	13	2	1	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	1	3	...	...	...	...	Nil.
22 „	70	35 small	5	...	...	...	...	...	...	...	...	...	4	6	...	4	...	...	1	...	1	1	1	1	...	...	1	3	1	6	...	...	...	14 per cent.
		35 large	6	...	...	...	...	...	...	...	...	...	10	5	1	1	1	...	...	3	2	...	...	1	1	1	...	1	8	...	...	...	...	Nil.

Remarks and Notes.

1. One egg collapsed, one that did not was returned to the water, where it eventually collapsed. 2. One egg collapsed. 3. All hatched. 4. All hatched. 5. Five collapsed. 6. All hatched.

Experiment No. VI.

EFFECT ON HATCHING OF SUBMERGENCE IN A SMALL OR LARGE QUANTITY OF WATER.

(*a*) Eggs Laid by a Single Female.

A female that emerged on 4th or 5th October was kept in a cage with several males for two or three days; she was then segregated and given daily opportunities of feeding on human blood.

The eggs were collected each day and divided into two lots, which were placed in separate glass dishes. These were then submerged in the same pans as those used for Experiment No. V.

All the eggs were kept submerged until 8th January. When they were dried, the single unhatched egg of Lot 1 did not collapse and was returned to the water.

Date of laying.	Number laid.	Numbers in each lot.	Reference number.	Date of hatching.														Mortality.
				October.							November.							
				12	14	15	16	17	20	28	3	13	20	22	23	24	30	
9 October ...	14	7 (small)	1	1	...	...	...	...	...	1	...	...	...	2	1	1	...	14 per cent.
		7 (large)	2	...	...	...	...	...	3	...	...	1	...	3	...	...	...	Nil.
10 ,, ...	45	22 (small)	3	...	4	1	...	...	...	...	...	...	1	13	...	2	1	Nil.
		23 (large)	4	...	2	1	2	1	...	1	3	...	10	3	...	...	...	Nil.

Remarks and Notes.

1. The remaining egg subsequently collapsed.

The female disappeared out of jar on the 12th October. (Either eaten by ants or escaped, owing to some meddlesome person lifting the jar.)

Experiment No. VII.

EFFECT ON HATCHING OF SUBMERGENCE IN A SMALL OR LARGE QUANTITY OF WATER.

(*b*) Eggs laid by more than one Female.

The batch of 192 eggs used for this experiment were laid in a cage containing a number of *S. fasciata* of both sexes. All the eggs were laid on the same night.

*The eggs were placed in small floating docks with a silk gauze bottom and allowed to sink or float as chance determined.

The water used was rain water that had been exposed to sun and air for a week and then strained through fine gauze.

Lot *A*, consisting of 94 of the above batch of eggs, was placed in a single dock floating in a small pan containing 100 cc. of water.

Lot *B*, consisting of 98 of the above batch of eggs, was distributed over 4 docks floating in a large pan containing 4,000 cc. of water.

Lot and number of eggs.	Date of hatching.											
	October.								November.			
	22	23	24	25	26	27	29	30	1	2	9	14
A. (small pan) 94 eggs ...	11	27	15	...	9	6	3	4	6	6	1	...
B. (large pan) 98 eggs ...	3	29	40	10	1	...	...	...	...	...	...	1

A. Total hatched at 30th November, 88 = 94 per cent.

B. " " " " 84 = 86 "

This experiment had to be abandoned at the end of November as a wild female got through the mosquito netting cover of the pan containing Lot *B* and oviposited in one of the docks.

* This method was adopted in order to avoid the expenditure of the time required to sink so large a number of eggs, and also because of the essential difficulties of proving hatching if the eggs were simply allowed to scatter in a large pan. For full details of the method see description on page 178 and illustrations Plate 29 and Figure 27.

Experiment No. VIII.

EFFECT ON HATCHING OF SUBMERGENCE IN A SMALL OR LARGE QUANTITY OF WATER.

(*b*) Eggs laid by more than one female.

The 400 eggs used in this experiment were laid in a cage containing a number of both sexes.

The period during which the eggs were laid covered forty-eight hours.

The eggs were placed in floating docks.

The water used was from the pipe service at Freetown.

Lot *A*, consisting of 200 eggs, were placed in a single dock floating in a small pan containing 100 cc. of water.

Lot *B*, consisting of 200 eggs, were distributed in two docks floating in a large pan containing 4,000 cc. of water.

Lot and number of eggs.	Date of Hatching.																																	
	October.								November.																			December.	January.		February.			March.
	24	25	26	27	28	29	30	31	1	5	6	7	8	9	*10	11	12	13	14	15	16	17	20	22	23	27	28	10	24	28	11	16	18	5
A (small pan) 200 eggs ...	11	49	12	...	...	1	3	...	...	2	...	1	...	1	36	6	3	1	...	3	1	...	...	...	...	...	...	...	...	...	...	...	...	...
B (large pan) 200 eggs ...	1	10	45	3	2	1	8	1	7	4	4	3	1	2	5	7	2	8	2	8	14	2	1	2	4	2	2	1	1	2	2	1	1	1

A. Total hatched, 130. Mortality, 35 per cent.

B. ,, ,, 160. ,, 20 ,,

* The morning of the 10th November was cooler than on the two previous days (80° F. on 8th, 78° F. on 9th, 76° F. on 10th). It is possible that this may have had some effect on the smaller quantity of water in lowering the temperature which was not operative in the large pan. It must be mentioned, however, that no similar occurrence was observed in the pans containing eggs of batches belonging to other experiments.

Experiments Nos. V., VI., VII. and VIII. afford no very decisive answer to the first question. The most it is possible to say is that within the limits of the experiment the smaller quantity of water raised the percentage of mortality and was possibly responsible for some delay in hatching in Experiments Nos. V., VI. and VII., while Experiment No. VIII. tends to obscure the issue on this point. A very interesting fact clearly brought out by the series is, however, the length of the period which may elapse between the immersion of the egg and its hatching even when no dry period intervenes. In the Experiments No. V. and No. VI. periods of 40 to 50 days are shown, while in Experiment No. VIII. a few of the eggs waited 4 or 5 months before hatching.

*Experiment No. IX.**

EFFECT ON HATCHING OF EARLY OR DEFERRED IMMERSIONS.

(*a*) Eggs laid by a single Female.

A female that emerged on the 8th or 9th October was placed in a cage with several males and then captured whilst paired. She was then segregated and given daily opportunities of feeding on human blood.†

The eggs were collected each day (except when the number laid was very small) and divided into two lots, one of which were at once placed in a floating dock (I) while the other (D) were stored dry for a period of a month or more. They were then treated in the same way as the other lot.

The eggs were allowed to sink or float as chance directed.

‡ Date of laying.	Numbers laid and in each lot.		Reference Number.	Date of hatching. October.													November.																				December.										January.		Reference Number.
				16	17	19	20	23	24	25	26	27	28	29	30	31	2	4	5	6	7	8	9	10	11	12	14	15	16	18	19	20	23	24	28	30	1	11	12	14	15	16	17	18	19	21	7	20	
12 October ...	62	D 31	1																																						5	5	2	3	4	1			1
		I 31	2	31																																													2
13 ,, ...	48	D 24	3																																						1	1							3
		I 24	4	14	5																																												4
16 ,, ...	31	D 16	5																																						9	3							5
		I 15	6			4	9																																										6
19 ,, ...	58	D 29	7																																						1	21	1						7
		I 29	8					14	4	3	1																																				2		8
23 ,, ...	75	D 37	9																																						3	32							9
		I 38	10								30	1	1															1																					10
26 ,, ...	57	D 28	11																																							11							11
		I 29	12											3	12	2	5																	1																	12
30 ,, ...	52	D 26	13																																							13							13
		I 26	14														18	1					1																										14
3 November	55	D 27	15																																													21	15
		I 28	16															2	4	6	1	2																									1		16
8 ,,	50	D 25	17																																													2	17
		I 25	18																					2	15	1																							18
12 ,,	30	D 15	19																																													11	19
		I 15	20																									16	1																				20
16 ,,	39	D 20	21																																													4	21
		I 19	22																											3	7	1	1																22
21 ,,	31	D 16	23																																													13	23
		I 15	24																															12	3														24
27 ,,	18	D 9	25																																													3	25
		I 9	26																																	2	6												26
8 December	48	D 24	27																																													1	27
		I 24	28																																			5	9										28
10 ,,	11	D 5	29																																													1	29
		I 6	30																																					1	2								30
12 ,,	46	D 23	31																																														31
		I 23	32																																						1								32

No more fertile eggs laid. The female was destroyed by ants on 10th January; life 95 days.

* The companion experiment to No. IX. failed, owing to the premature death of the female.
† *See* Record of feeding and egg laying (page 34) for further details.
‡ When only a few eggs were laid they were included in the previous or following batch.

[*To face page* 33.

Immediately Immersed Lots.

Some of the apparent mortality or infertility among the immediately immersed eggs must be attributed to the method employed of allowing them to either sink or swim in floating docks. While convenient in many ways for observation and effecting a very large saving in time and labour, this system is not without its drawbacks. Chief among these there is the fact that, after a few weeks' immersion it becomes impossible to follow up all the eggs individually, owing to the wood and gauze forming the docks becoming discoloured, while some of the eggs get washed into crevices at the junction of the wood and gauze.

The rusting of the tins used (in the absence of glass pans) was the cause of much discolouration. There may also have been a few actual losses owing to the gauze bottom of the docks rotting or fraying through with the lapse of time.

The docks containing the immediately immersed lots were taken from the water and dried in sequence between the 10th November and the 7th January in order to make room for those containing the later lots—the same water being used throughout. They were subsequently returned to the water, but it will be noted that only in the case of Lots Nos. 8 and 16 did eggs hatch after re-immersion.

Lots in which Immersion was Deferred.

No. 1.	5 eggs showed signs of collapse within three days of drying.
No. 3.	3 ,, ,, ,, ,, ,, ,, ,,
No. 5.	2 ,, ,, ,, ,, ,, ,, ,,
No. 7.	2 ,, ,, ,, ,, ,, ,, ,,
No. 9.	(No record).
No. 11.	4 eggs showed signs of collapse within three days of drying.
No. 13.	4 ,, ,, ,, ,, ,, ,, ,,
No. 15.	5 ,, ,, ,, ,, ,, ,, ,,
No. 17.	4 ,, ,, ,, ,, ,, ,, ,,
No. 19.	
No. 21.	
No. 23.	
No. 25.	(No record).
No. 27.	
No. 29.	
No. 31.	

On the 14th December, Lots Nos. 1, 3, 5, 7, 9, 11, and 13 were examined :—

No. 1.	31 eggs present; 5 collapsed.
No. 3.	24 ,, ,, ; 4 ,,
No. 5.	16 ,, ,, ; 2 ,,
No. 7.	29 ,, ,, only partially examined; 23 were full.
No. 9.	36 ,, ,, ,, ,, ,, ; no collapsed seen.
No. 11.	28 ,, ,, ; 8 collapsed.
No. 13.	26 ,, ,, ; 4 ,,

All these seven lots were placed in floating docks on the 14th December.

On the 19th January Lots Nos. 15, 17, 19, 21, 23, 25, 27 and 29 were examined :—

No. 15.	26 eggs present;	all but 15 more or less collapsed.
No. 17.	8 ,, ,,	,, ,, 4 ,, ,, ,,
No. 19.	15 ,, ,,	,, ,, 6 ,, ,, ,,
No. 21.	14 ,, ,,	,, ,, 5 ,, ,, ,,
No. 23.	16 ,, ,,	,, ,, 13 ,, ,, ,,
No. 25.	9 ,, ,,	,, ,, 1 ,, ,, ,,
No. 27.	4 ,, ,,	,, ,, 2 ,, ,, ,,
No. 29.	5 ,, ,,	,, ,, 2 ,, ,, ,,

All these eight lots were placed in floating docks on the 19th January.

Unfortunately, the term "collapsed" was applied, during the early course of the experiment, to all eggs that showed marked signs of shrinkage, it being at that time considered that this was a certain forerunner of complete collapse, and that such eggs were infertile. Subsequent experience proved that this was not necessarily the case, as it was observed that partially collapsed eggs, when wetted may either hatch at once or recover their full rotundity and hatch later on.

The loss in numbers of Lots Nos. 17, 21, and 23 can only be accounted for on the assumption that they had been destroyed and eaten by *Psocidæ*, which had managed to get through the close fitting lids of the boxes in which the eggs were kept. These enemies had only penetrated into the boxes in which these three lots were kept.

Feeding (on Blood) and Egg-Laying of *Stegomyia fasciata*.

Record of female used in Experiment No. IX.

Date of feeding and egg-laying.	Number of eggs laid.	Remarks *re* feeding.	Date of feeding and egg-laying.	Number of eggs laid.	Remarks *re* feeding.
12 October ...	62	Did not feed.	17 November...	...	Fed.
13 ,, ...	48	Fed.	18 ,, ...	...	,,
14 ,, ...	...	,,	20 ,, ...	...	,,
16 ,, ...	31	,,	21 ,, ..	31	,,
19 ,, ...	59	,,	26 ,, ...	7	,,
20 ,, ...	...	,,	27 ,, ...	11	Did not feed.
23 ,, ...	75	,,	28 ,, ...	...	Fed slightly.
24 ,, ...	...	,,	1 December...	...	Fed.
26 ,, ...	55	,,	3 ,, ...	...	,,
27 ,, ...	2	,,	4 ,, ...	...	Bit, drew very little (if any) blood.
28 ,, ...	...	,,			
29 ,, ...	...	,,			
30 ,, ...	52	,,	8 ,, ...	47	Fed.
31 ,, ...	...	,,	9 December...	1	,,
1 November...	...	,,	10 ,, ...	11	,,
2 ,, ...	7	Did not feed.	12 ,, ...	46	,,
3 ,, ...	48	,, ,,	14 ,, ...	...	Bit.
4 ,, ...	3	,, ,,	18 ,, ...	32	Fed.
5 ,, ...	...	Fed.	19 ,, ...	...	Fed slightly.
6 ,, ...	...	Fed slightly.	22 ,, ...	...	,, ,,
8 ,, ...	47	Fed.	23 ,, ...	3	Did not feed.
9 ,, ...	...	,,			
11 ,, ...	2	Did not feed.			
12 ,, ...	28	Fed.			
16 ,, ...	39	,,			

As only infertile eggs were being laid, a male was put in jar with the female.

Record of female used in Experiment No. IX.—continued.

Date of feeding and egg-laying.	Number of eggs laid.	Remarks *re* feeding.
24 December...	1	Fed slightly.
25 ,, ...	...	,, ,,
26 ,, ...	...	Bit.
27 ,, ...	20	Fed.
28 ,, ...	...	,,
29 ,, ...	2	Bit.
30 ,, ...	...	Fed.
1 January ...	5	Bit.
2 ,, ...	...	,,
3 ,, ...	3	Fed slightly.
4 ,, ...	4	,, ,,
5 ,, ...	...	Fed.
6 ,, ...	...	Fed slightly.

Date of feeding and egg-laying.	Number of eggs laid.	Remarks *re* feeding.
7 January ...	7	Did not feed.
9 ,, ...	...	...

As the male added on the 23rd December had died two fresh ones were added.

Date of feeding and egg-laying.	Number of eggs laid.	Remarks *re* feeding.
10 January ...	...	Fed heavily.
11 ,, ...	16	...

The female disappeared although both the males remained in the jar. I can only account for this by supposing that ants found their way in and carried off the female piecemeal.

10- to 15-minute opportunities of feeding on blood were afforded every night, but the dates on which egg-laying or feeding took place alone are recorded.

The last fertile egg was laid on the 12th December—63 days after separation from the males; at this time 712 eggs had been laid in 22 days. Allowing that eggs, when laid on following days, belong to the same batch (using this term to mean the ripe contents of the ovaries), this gives 15 batches of eggs within the fertile period.

The total number of eggs laid was 798, the last 87 being divided into 6 separate batches laid with intervals of more than a day between them.

The males introduced on the 23rd December and 9th January did not effect the fertilization of the eggs laid subsequently. During the period the males were with her, the female had the choice of feeding on honey as well as blood.

There is little doubt but that ants were responsible for the disappearance, as occasions in which legs, wings and other remains were left behind, as well as one instance when they were caught in the act, occurred during the course of the experiments. At the same time, I am disposed to consider that the female was nearly, if not quite, spent. It is possible, however, that if a chance of pairing had been given to her late in November, when signs of waning fertility at first began to show, that many of the late laid eggs might have proved fertile.

The evidence afforded by this experiment is, in a general sense, a sufficiently clear answer in the affirmative to Question (2), and the second portion of the question therefore falls.

In utilizing the evidence afforded by this experiment relating to the effect of immediate or deferred immersion (Question (3)), some preliminary precautions are necessary. Lots 17, 21 and 23 should be left out of account, as the ravages of book lice among the stored eggs not only reduced the numbers, but very probably, as their habit

is, perforated others and killed the larvæ, leaving the shells intact. It will be better also to exclude all the batches subsequent to 26, as the general infertility of the December-laid eggs is very obvious.

Taking Lots 1 to 16, 19/20 and 25/26, we find that of the immersed eggs 199, = 82 per cent., hatched out of 244, while of those stored dry for a month or more before immersion 173 = 72 per cent., hatched out of 242, the period of dry storage being apparently responsible for 10 per cent. mortality.

Two batches, however, laid on the 19th and 23rd of October, require special attention in this connection. The eggs were deposited on wet wood (fragments of willow chip boxes) in place of the usual filter paper. It will be observed that the percentage hatching in these batches is high, 86 per cent. and 91 per cent., while they afford the only instance in which the stored eggs show a lower mortality than the portion of batch immersed immediately after laying. From this it would appear that the material on which the eggs rest may be a factor in their survival during periods of drought, a conclusion which fits in with the facts already noted in the introductory remarks (*see* page 19) regarding the recovery of shape by shrunken eggs.

*Experiment No. X.**

EFFECT ON HATCHING OF EARLY OR DEFERRED IMMERSION.

(*b*) Eggs laid by more than one Female.

144 eggs were laid on the night of the 8th–9th October on filter paper in a cage containing numbers of *S. fasciata* of both sexes.

These were divided into two lots—*A*, 66 eggs, which were immersed on the 9th October, and *B*, 78 eggs, which were allowed to slowly dry and then stored in the animal house until the 17th November, when they were immersed, 39 days after laying.

*In this and the following experiments, as well as in other cases where eggs were stored dry, woodlice and small insects, such as ants and *Psocidæ*, easily gained entrance to the eggs in paper envelopes, and, with the exception of the larger woodlice, to the wire gauze tubes as well. *Psocidæ* even penetrated into entomological boxes unless the lids fitted very tightly.

The surface of the filter paper on which the eggs were laid was often gnawed off in patches and numbers of eggs had disappeared. No evidence that either ants or woodlice intentionally destroy eggs was obtained, but, on the other hand, there is definite proof that *Psocidæ* do so. See account under "Enemies," page 59, Experiment No. XXII.

LOT *A*.

	Date of hatching.						Number of eggs which hatched prior to storage.	Percentage.
	October.							
66 eggs laid on the night,	12	13	14	18	19	20		
8—9 October ...	3	20	11	1	2	1	38	57

On the 7th November, after 29 days' immersion, Lot *A* was taken from the water and stored dry in the Laboratory until the 22nd January (76 days). An examination showed 3 full and 16 shrunken eggs, the remainder having collapsed; the eggs were then transferred to the mosquito house and placed under shelter. They were finally immersed on the 29th April after 173 days' storage without water. None hatched, and dissection showed that all the unhatched eggs were dead.

LOT *B*.

Was examined on the 17th November after 39 days' storage; 9 of the eggs had collapsed. The lot was then immersed in water. After 3 days none of the eggs having hatched, the pan was placed in the ice chest, the temperature of the water falling within 2 hours from 81° F. to 73° F.; 7 eggs hatched while in the ice chest. The pan was then kept at Laboratory temperature until the 4th January.

	Date of hatching.				Number of eggs which hatched after storage.	Percentage.
	November.			December.		
78 eggs laid on the night,	20	22	23	21		
8—9 October ...	7	28	6	1	42	54

On the 4th January, after 48 days' immersion, the lot was removed from the water, dried, and stored in the mosquito house under cover until the 29th of April, when it was again immersed. None of the eggs hatched, and dissection proved that all were dead.

Experiment No. XI.

EFFECT ON HATCHING OF EARLY OR DEFERRED IMMERSION.

(*b*) Eggs laid by more than one Female.

493 eggs were laid between the 10th–14th October on filter paper in a cage containing numbers of *S. fasciata* of both sexes. These were divided into two lots—*A*, 197 eggs, which were immersed on the 14th October, and *B*, 196 eggs, which were slowly dried and then stored in the animal house until the 4th January, they were then immersed 82 days after laying.

Lot *A*.

	Date of hatching.						Number of eggs which hatched prior to storage.	Percentage.
	October.							
	14	15	16	17	18	20		
197 eggs laid 10—14 October ...	30	28	61	5	9	4	137	70

On the 7th November, after 24 days' immersion, Lot *A* was taken from the water and stored dry in the laboratory until the 22nd January (76 days). An examination showed 8 full and 24 shrunken unhatched eggs, the balance having collapsed; the eggs were then transferred to the mosquito house and placed under shelter. They were finally immersed on the 29th April after 173 days' storage. After 14 days' immersion, during which period they were twice cooled, the unhatched eggs were dissected. *One living larva* was extracted, the remainder were dead.

Lot *B*.

Was examined on the 4th January after 82 days; very many of the eggs were shrunken or collapsed. They were first put into a saturated atmosphere, and after 24 hours wetted by sprinkling and finally immersed; 4 hatched within 2 hours.

	Date of hatching.									Number of eggs which hatched after storage.	Percentage.
	January.										
	4	5	6	7	10	14	15	16	17		
196 eggs laid 10—14 October. Immersed 4 January	4	17	1	2	1	3	18	3	2	51	26

They were dried on the 26th January and stored in the mosquito house, under shelter, until the 29th April, and were then again immersed after 93 days' storage. None of the eggs hatched, and dissection proved them to be all dead.

Experiment No. XII.

EFFECT ON HATCHING OF EARLY OR DEFERRED IMMERSION.

(*b*) Eggs laid by more than one Female.

517 eggs were laid between the 14th–16th October on filter paper in a cage containing numbers of *S. fasciata* of both sexes. These were divided into two lots, *A*, 254 eggs, which were immersed on the 16th October, and *B*,

263 eggs, which were dried, placed in a wire gauze tube and suspended in the covered pit in the mosquito house until the 18th November, 33 days after laying.

LOT *A*.

	Date of hatching. October. 17	18	19	20	21	Number of eggs which hatched prior to storage.	Percentage.
254 eggs laid 14 – 16 October	70	87	27	17	1	202	80

On the 7th November, after 22 days' immersion, Lot *A* was dried and then stored in the Laboratory until the 22nd January (76 days). An examination showed 22 full and 22 shrunken unhatched eggs, the balance having collapsed; the eggs were transferred to the mosquito house and stored under shelter. They were then immersed again on the 29th April after 173 days' storage. *One hatched* on the 6th May and *one* on the 12th, both in response to cooling; but the larvæ died within a few hours of hatching. The remaining unhatched eggs were dissected; 2 were found to contain living larvæ, the remainder were dead.

LOT *B*.

Was examined on 18th November; it was found that the paper cover to the wire gauze tube was saturated with moisture, while the filter paper on which the eggs were laid was damp. 20 eggs had hatched owing to drops of water precipitated on the wire gauze having flooded single eggs or small groups of eggs; 13 eggs had collapsed; the remainder were immersed 33 days after laying.

	Date of hatching. November. 18	20	22	23	24	29	December. 4	9	12	18	Number of eggs which hatched after storage.	Percentage of unhatched eggs at date of immersion.
Survivors of 263 eggs laid 14–16 October	35	15	82	19	6	3	1	1	1	1	164	68

A few of the eggs hatched within 3 minutes of their immersion, 18 larvæ were out within one hour and 35 within three hours. None hatched on the 19th. On the 20th November the pan was placed in the ice chest; in two hours the temperature of the water fell from 80° F. to 73° F., 15 hatched; the pan was then kept at Laboratory temperature until 3rd December, when it was placed in an incubator at 97° F. for two hours. Owing to an accident 18 unhatched eggs were lost. On the 4th January Lot *B* was dried and stored under shelter in the mosquito house until 29th April, when it was again immersed. No larvæ emerged, and dissection showed that all the unhatched eggs were dead.

Experiment No. XIII.

EFFECT ON HATCHING OF EARLY OR DEFERRED IMMERSION.

(*b*) Eggs laid by more than one Female.

580 eggs were laid between the 16th and 19th October, on filter paper, in a cage containing numbers of *Stegomyia fasciata* of both sexes. These were divided into two lots, *A*, 275 eggs, which were immersed on the 19th October, and *B*, 305 eggs, which were dried, placed in a wire gauze tube, wrapped in paper, and placed under dead leaves in the mosquito house.

Lot *A*.

	Date of hatching.									Number of eggs which hatched prior to storage.	Percentage.
	October.					November.					
	19	20	21	22	23	2	3	4	6		
275 eggs laid 16—19 October.	16	92	47	18	26	1	1	1	4	206	75

On the 17th November, after 19 days' immersion, Lot *A* was dried and stored in the Laboratory until the 22nd January (76 days). An examination showed 13 full and 16 shrunken eggs—the remainder of the unhatched eggs having collapsed. The eggs were transferred to the mosquito house and stored under shelter till the 29th April, when they were again immersed after 173 days' storage.

On the 2nd May, 1 hatched and died shortly after emerging.
„ „ 4th May, 3 „ one of which died.
„ „ 6th May, 1 „ 199 days after laying.

Dissection showed the remaining eggs to be dead.

Lot *B*.

Was examined on the 9th March, after 141 days' storage; the paper covering of the tube had been mostly eaten off—woodlice and millipedes were present on the outside of the tube, ants and *Psocidæ* in the interior. One of the four slips on which the eggs had been laid was taken out, the tube was recovered with paper and replaced under the leaves. Only 27 eggs were found on the slip in place of the 50 originally laid on it. Of these by far the larger number had already hatched, probably during heavy and prolonged rain in November or December; 2 eggs were full, 18 had hatched, and 7 had collapsed more or less completely. This portion of Lot *B* was immersed on the 9th of March and on two occasions between this date and the 20th of the same month, the paper with the eggs on it was lifted and cooled by exposure to draught.

1 hatched on the 20th—152 days after laying; a male was bred.
1 „ „ 24th—this larva died shortly after emergence.
1 „ „ 30th—this larva was dead when found.

All the remainder proved to be dead when opened.

On the 21st April, after 6 months' storage, the remaining 3 slips of Lot *B* were examined and then immersed :—

4 hatched when cooled on 23rd April, 186 days after laying.

1 ,, ,, ,, for the second time, on the 27th April, and died shortly after emerging.

1 hatched when cooled for the third time, on the 12th May, 205 days after laying.

Of the 305 eggs stored, 27 were found on the slip taken out on the 9th March, and 122 on the 3 slips examined on the 21st April; in all 149 eggs. Of these, 43 had more or less completely collapsed; 9 retained their shape and 97 had hatched while stored. 9 eggs hatched.

These experiments (Experiments X. to XIII.), while affording interesting general information relating to Question (3), fail to give a decisive answer to that portion of it which concerns a possible proportional relation between mortality and period of storage. This is due to the destruction by *Psocidæ* (book lice) of large numbers of the stored eggs in some of the experiments, and sufficiently numerous attacks in the case of others to throw doubt on the validity of the results. Such a heavy reduction of numbers was not foreseen, and in any case would have been difficult to guard against without entirely militating against natural conditions, as it would have been necessary to enclose the eggs in tubes or boxes with all but air-tight lids. Unfortunately, the cause of the reduction was not recognised until a late stage of the work, otherwise a careful examination of the stored eggs in Experiments Nos. X. and XI. might have allowed of some definite proportional results being arrived at. The excess in mortality, after 39 days' storage, of Lot *B* in Experiment No. X., is only 3 per cent., which, in view of the foregoing explanation, is probably devoid of significance.

In Experiment No. XI. the excess in mortality amounts to 40 per cent., which may be partly attributable to the lengthened period of storage, but in any case a very considerable allowance must be made for the destruction of eggs by these small enemies.

Experiment No. XII. was designed to contrast with No. X., the stored eggs being kept under very humid conditions. If allowance be made for a difference in the constitution of the eggs used, as shown by the different percentages which hatched of the unstored eggs in the two experiments, it would appear that storage under humid conditions, for the short period involved, affords no advantage.

Experiment No. XIII. Although such an extensive destruction of the stored eggs was disappointing, still a larger wastage than in the other experiments was to be expected, both on account of the longer period of time involved and also because the conditions of

storage rendered the eggs not only more liable to the attacks of other insects but to be washed away by heavy rains as well. The reduced numbers are so small that but little reliance can be placed on any conclusion concerning these hatchings, more especially as it is uncertain to what extent the collapsing resulted from the attacks of book lice or from natural causes. If only the apparently sound eggs are considered, the result shows that 6 eggs out of 9 hatched (or 66 per cent.). This is probably far too high for a general survival rate under the conditions in the light of general experience, as apart from actual experiment, which suggests that long storage is certainly responsible for an increased mortality, apart from the attacks of enemies.

The Effect of Changes of Temperature.

The possibility of changes of temperature affecting the hatching of eggs was recognised at an early stage of the research. The preliminary trials which formed the basis for Question (4) suggested that a rapid fall of a few degrees Fahr. acted as a stimulus to induce the hatching of resting or resistant eggs, whereas an equivalent rise had little, if any, influence

The following experiments were then carried out, two plans being employed. In the first, which relates to cold only, eggs of many different stocks and layings which proved to be resistant under previous long continued immersion or repeated dryings and wettings, were cooled by one or other of the following methods :—

(1) By exposing the dry eggs to rain on a cool day.

(2) By placing the pans of water in which the eggs were immersed in an ice chest.

(3) By lifting the filter paper on which the eggs were lying from the pan of water and exposing it to rapid evaporation in a strong draught of dry air.

It is to be noted that in (2) and (3) the eggs had been kept immersed for several days before the trial, so that the larvæ had had opportunity of emerging right up to the time of the test. On the other hand, in method (1) the eggs, though already proved to be resistant, had been kept dry for a longer or shorter time before the trial.

In the second plan a large batch of eggs laid between the 23rd November and 7th December in a cage containing a number of *S. fasciata* was employed. One portion was stored dry while the other was immersed until all the eggs ready to hatch had done so.

The resistant eggs, which did not respond within a period of 17 days' immersion, were divided, one portion being submitted to a rapid rise of temperature by placing the pan containing them in an

incubator at 95° F., while the pan containing the other portion was transferred to the ice chest.

The subsequent history of all the eggs that proved resistant to these conditions was, so far as possible, followed up.

Experiment No. XIV.

EFFECT OF COOLING ON RESISTANT EGGS OF VARIOUS BATCHES.

(1) By placing in rain on a cool, wet day (2nd December, 1914).

After remaining in the rain for about thirty minutes the eggs were placed in rain water and left out of doors for an hour. (The fall of the dry bulb of the hygrometer was less marked than that of the wet bulb on the 2nd December, 1914).

Reference to source from which the eggs were taken.	Date when the eggs were laid.	Number of eggs in the original batch as laid.	Number which hatched within 4 hours.	Number which hatched within 20 hours.	Notes regarding the previous history of the resistant eggs or the batches of which they formed part.
S. fasciata: —					
Exp. No. II., No. 7	5 Oct.	37	4	3	This batch of eggs had been immersed for 34 days before drying, but none of the eggs hatched.
Exp. No. II., No. 10	12 ,,	4	1	...	Immersed for 27 days before drying. No larvæ had emerged.
Exp. No. II., No. 11	13 ,,	18	4	...	Immersed for 26 days before drying. Only 1 larva had emerged.
Exp. No. II., No. 12	14 ,,	31	2	...	Immersed for 25 days before drying. No larvæ had emerged.
From Fertility Experiment: —					
B. II.	3 Nov.	35	4	...	Only 4 larvæ emerged during the period of immersion after laying, the resistant eggs had been dried and immersed several times without effect.
B. III.... ...	2 ,,	84	5	...	47 larvæ emerged within 4 days of laying; the resistant eggs had been dried and re-immersed on several occasions without effect.
B. III.... ...	5 ,,	80	1	...	65 larvæ emerged within 4 days of laying, and the resistant eggs had been dried and immersed several times without effect.
B. IV.... ...	11 ,,	28	3	...	13 larvæ emerged within 4 days of laying, and the resistant eggs had been dried and re-immersed 3 or 4 times without effect.
C. I.	7 ,,	30	1	...	3 larvæ emerged within 6 days of laying; the resistant eggs had been dried and re-immersed several times without effect.
C. VII. ...	13 ,,	16	5	...	No larvæ had emerged within 10 days of laying, and the whole batch had been dried and re-immersed 3 or 4 times without result.

Experiment No. XV.

EFFECT OF COOLING ON RESISTANT EGGS OF VARIOUS BATCHES.

(2) By placing the pans of water in which the eggs were immersed in an ice chest.

Fall of Temperature from 81° F. to 73° F. Time in ice chest, about 2 hours.

Reference to source from which the eggs were taken.	Date when eggs were laid.	Number of eggs in the original batch as laid.	Number which hatched within 3 hours.	Number which hatched within 20 hours.	Number which hatched within 44 hours.	Notes with regard to the previous history of the resistant eggs submitted to the test.
S. sugens ...	27 Oct.	20	3	...	...	After several wettings and dryings had remained immersed for 6 days without any hatching.
S. fasciata:—						
Exp. No. X. ...	8/9 Oct.	70	7	...	28	The whole batch had been kept dry for 39 days before it was immersed. None of the eggs hatched in the 3 days that elapsed between immersion and cooling.
Exp. No. XII.	13/14 Oct.	263	15	...	82	The whole batch was kept dry for 33 days before its immersion. 35 larvæ emerged within 3 hours of the eggs being placed in water, but none hatched on the following day. On the third day after immersion the water was cooled.
Exp. No. II., No. 4	24 Sept.	32	2	...	...	After 4 periods of drying and wetting which followed the first immersion the resistant eggs had been immersed for several days prior to cooling.
Exp. No. II., No. 13	18 Oct.	18	...	...	...	After the first period of immersion the resistant eggs were dried; they had been again immersed for several days before cooling took place. *No effect.*
From Fertility Experiment:—						
B. III.... ...	14 Nov.	84	...	...	...	Batch was immersed for first time on 18th Nov. when 27 hatched; on the 19th 31 hatched; none on the 20th; cooled on 21st. *No effect.*
B. IV.	8 Nov.	5	...	1	...	Immersed for 4 days prior to cooling.
C. I.	10 Nov.	31	6	2	...	,, 6 ,, ,,
C. I.	13 Nov.	18	1	...	...	,, 4 ,, ,,
C. I.	16 Nov.	37	...	1	...	,, 1 ,, ,,
C. IV.	13 Nov.	45	8	10	...	,, 4 ,, ,,
C. V.	15 Nov.	28	...	2	...	,, 1 ,, ,,

Experiment No. XVI.

EFFECT OF COOLING ON RESISTANT EGGS OF VARIOUS BATCHES.

(3) By lifting the filter paper on which the eggs were lying from the water and exposing to a strong draught when the harmattan was blowing (28th December), the eggs being re-immersed in the same water before they were dry.

Reference to source from which the eggs were taken.	Date when the eggs were laid.	Number of eggs in the original batch as laid.	Number which hatched within 1 hour.	Notes relating to the previous history of the eggs used.
S. fasciata :—				
Exp. No. II., No. 4	24 Sept.	32	...	Used in Cooling Experiment, No. XV.
,, No. 10	12 Oct.	4	...	,, ,, ,, No. XIV.
,, No. 11	13 ,,	18	2	,, ,, ,, No. XIV.
,, No. 12	14 ,,	31	1	,, ,, ,, No. XIV.
,, No. 14	19 ,,	16	1	A resistant batch, see notes to Exp. No. II., No. 14.
,, No. 15	21 ,,	23	...	A resistant batch, see notes to Exp. No. II., No. 15.
From Fertility Experiment :—				
A. II.	27 Oct.	9	2	Resisted long immersion and several dryings.
B. II.	3 Nov.	35	...	Used in Cooling Experiment, No. XIV.
B. III.	5 ,,	80	...	,, ,, ,, ,,
B. III.	2 ,,	84	...	,, ,, ,, ,,
B. IV.	11 ,,	28	1	,, ,, ,, ,,
C. I.	7 ,,	30	...	,, ,, ,, ,,
C. I.	29 ,,	21	1	Resisted a long period of immersion.
C. I.	3 Dec.	23	...	Resisted long immersion; 2 hatched when cooled on 24th December.
C. VII.	13 Nov.	16	2	Used in Cooling Experiment No. XIV.
C XIX.... ...	3 Dec.	47	1	Resisted 20 days' immersion.

Experiment No. XVII.

EFFECT OF CHANGES OF TEMPERATURE ON THE HATCHING OF EGGS OF *STEGOMYIA FASCIATA*.

The eggs used were laid on wet filter paper in a cage containing numbers of adults, between the dates 23rd November and the 7th December. The batch contained approximately 1,300 eggs*. About 600 of these (Lot *B*) were dried and stored dry from the 7th December until 24th March (107) days. The other portion (Lot *A*), about 700 eggs, were at once immersed in water without the filter paper on which they were laid being allowed to dry.

138 eggs (about 20 per cent.) hatched between 7th December and the 13th; the batch was, however, kept immersed until the 24th December, although no more larvæ emerged.

DETAILS OF HATCHING.

LOT *A*.	DECEMBER.							NUMBER OF EGGS WHICH HATCHED.	PER-CENTAGE.
	7	8	9	10	11	12	13		
About 700 eggs laid 23rd November to 7th December...	8	69	42	11	3	4	1	138	about 20

Lot *A* was then divided into two portions : *A*1, containing about 420 eggs and shells ; *A*2, containing about 250. *A*1 was placed in a pan with a portion of the water in which they had been immersed since the commencement of the experiment, and placed in an ice chest for 90 minutes—the temperature of the water falling from 80° F. to 74° F. The smaller lot, *A*2, was treated similarly as regards transfer, but the pan was placed in an incubator for the same period of time—the temperature of the water rising from 80° F. to 95° F. Eggs hatched as under :—

A1† "Cooled," within $1\frac{1}{2}$ hours 102
,, $2\frac{1}{2}$,, when the temperature had risen again to 80° F. ... 4
,, $3\frac{1}{2}$,, ... 1
,, 24 ,, ... 0

Total ... 107 = about 25 per cent.

* The difficulties of counting large numbers of these small eggs is considerable. Laid in scattered but closely approximating groups, the individual eggs are often in contact; accuracy in counting was only possible at an expenditure of time which was not available without sacrifice in other directions.

† 12 larvæ from each Lot, *A*1 and *A*2, were reared under precisely similar conditions :—
Of the "Heated," 7 attained maturity ; mortality 41 per cent.
,, "Cooled," 11 ,, ,, ; ,, 8 ,,

A2* "Heated" within 1½ hours 2
„ 2½ „ when the temperature had again fallen to 80° F. 6
„ 3½ „ 26
„ 24 „ 6

Total ... 40 = about 16 per cent.

On the day following the first test, both pans were put into the ice chest for 2½ hours; the temperature of the water fell from 80° F. to 73° F.; eggs hatched as follows:—

*A*1 "Cooled," within 2½ hours 2
2 days after 1

3

*A*2 "Heated," within 2½ hours 13
5 days after 1
7 days after 1

15

Adding these figures to those previously obtained, we find that 104 resistant eggs hatched in response to cooling—about 25 per cent. of the original Lot *A*1; of those submitted to heat only two actually emerged in response to the rise of temperature, about 1 per cent. of the original Lot *A*2, but that 53 hatched in response to falls of temperature subsequent to heating—about 21 per cent. This would seem to indicate that the temperatures employed had little, if any, effect, the actual stimulus being in both cases cooling in relation to the previous condition.

On the 4th January Lots *A*1 and *A*2 were lifted from the water and stored dry with Lot *B* until the 24th March (79 days). An examination of all three lots on that date showed that the number of eggs or shells in each lot had been reduced by 10 to 15 per cent., either owing to eggs becoming detached from the paper on which they were laid or, as I think, from the depredations of *Psocidæ*.

The three lots were immersed in separate pans on the 24th March, cooling in an ice chest being resorted to as opportunity occurred. The dates on which cooling took place are indicated by an asterisk. The fall in temperature of the water, which placing in the ice chest caused, was generally about 6° or 8° F.

On the 19th April the experiment had to be closed, owing to an accident.

At this point the influence of cooling is, however, sufficiently obvious for all practical purposes, although its effect differs in detail as regards Batch *A* (1 and 2) on the one hand, and Batch *B* on the other, probably

* 12 larvæ from each lot, *A*1 and *A*2, were reared under precisely similar conditions:—
Of the "Heated," 7 attained maturity; mortality 41 per cent.
„ "Cooled," 11 „ „ ; „ 8 „

because the less resistant eggs had not been weeded out of the latter batch by immersion prior to storing.

Dates of hatching of Lot *B* and the balance of the resistant eggs of Lots *A*1 and *A*2.

Lot.	March.						April.														
	25	26	27	28	29	30	2	5	6	7	8	9	10*	11	12†	13	14	15	16	18‡	19
*A*1 (cooled)...	...	10	...	...	1	2	1	...	...	1	...	...	7	3	41	12	3	1	...	6	3
*A*2 (heated)...	...	1	...	...	...	2	...	...	1	2	...	...	16	4	23	3	...	...	...	1	3
B (stored dry)	109	15	16	17	6	...	...	1	1	1	2	1	32	22	3	5	3	...	2	4	5

* On the 10th April the eggs hatched within 1 hour of the *commencement* of the cooling.
† The second cooling on the 12th April was slight, the fall being only 3° or 4° F., but it was long continued, lasting 5 hours.
‡ The third cooling on the 18th April was for 1 hour, the fall being from 85° F. to 74° F.

The final figures, although only approximate, are worth consideration. Of Batch *A*, 20 per cent. hatched on first immersion. Of the cooled resistant eggs (*A*1), 27 per cent. had hatched before they were dried and stored; 22 per cent. hatched subsequently, or, altogether, 49 per cent. Of the heated resistant eggs (*A*2), 22 per cent. hatched before and 22 per cent. after drying and storing; altogether 44 per cent.

The total number of Batch *A* which hatched is therefore 64 per cent., while of Batch *B* 41 per cent. hatched up to the time of the accident.

Of the totals, 36 per cent. of *A* had hatched in response to lowered temperature, and of *B*, 9 per cent.

The evidence afforded by these experiments seems fairly conclusive testimony that "cooling" is an important stimulus to hatching, and most probably is the effective factor when eggs are dried and re-immersed, or when fresh water is added to the pan containing the eggs.

It is to be noted that there is an underlying constitutional variability which withholds some of the eggs from hatching in spite of the stimulus. This appears to be of a zone-like character; that is to say, repetition of the stimulus at short intervals is less effective than if it is again applied after a greater lapse of time.

A further complexity arises from the fact that the zone-like character of this constitutional resistance to *stimuli*, together with the *resting habit as a whole*, may be suspended, with the exception of a small percentage of eggs, if certain conditions prevail at or about the period of incubation.

The experiment (No. XVIII.) performed to elucidate Question (7) was only planned and carried through at a late stage of the research when time did not permit of its repetition. The evidence it affords is, however, so definite and conclusive, with regard to the determining powers of drought or humidity (subsequent to incubation) either to bring the resting habit into action or to allow it to remain latent, that the only point remaining to be solved would seem to be whether the effect is invariable and relates to all eggs laid or if it is occasional only, relating possibly to a seasonal change in the constitution of the eggs. An answer on this last point would require a series of experiments carried out at, say, monthly intervals and continued over a period of 18 months to 2 years.

Experiment No. XVIII.

IMPORTANCE OF DRY OR HUMID CONDITIONS AS FACTORS IN INDUCING THE IMMEDIATE OR DEFERRED HATCHING OF EGGS.

A pan of water with two strips of filter paper, one end of which dipped into the water, while the other hung over the rim, was placed in a cage where females of *S. fasciata* were laying freely. Over 400 eggs were deposited on the filter paper during the night of the 10th April. The pan, with the eggs undisturbed, was then placed in a moist chamber (saturated atmosphere) for 50 hours to allow the eggs to incubate. A few of the eggs that were exactly on the water level or partly submerged, hatched.

The unhatched eggs were then divided into lots, one of which, Lot *A*, containing 192 eggs, was immediately immersed in a pan of water. 189 of the eggs hatched within 30 minutes. The 3 resistant ones, which were short, stumpy eggs, were kept immersed for 10 days; they were then dried and partly collapsed. They were again immersed for another 20 days and then dissected. Two contained dead larvæ and from the other a living larva was extracted.

The other portion of the batch, Lot *B*, containing 193 eggs, was allowed to dry on the bench. By the next day the number had been reduced to 168, owing to the attacks of *Psocidæ* (a species belonging to the genus *Clothilla*). Of this 168, 43 were more or less collapsed. (To a greater or less extent this collapsing may have been due to the *Psocidæ* perforating the eggs.)

Lot *B* was divided into :—

*B*1. Containing 86 eggs (15 of which were more or less collapsed). These were immersed after 24 hours' drying.

*B*2. Containing 82 eggs (28 of which were more or less collapsed). These were immersed after 7 days' drying.

The pans containing *B*1 and *B*2 were kept together and treated exactly alike as regards "cooling."

Results.

*B*1.—86 eggs, 15 of which were more or less shrunken, were immersed after 24 hours' drying on the 14th April.

Lot *B*1.	Date of hatching.														Total which hatched.	Percentage which hatched.
	April.		May.				June.									
	15	28	12	19	20	21	5	10	11	12	14	16	18	19		
Immersed 14th April ...	18	12	4	...	1	...	1	2	8	1	11	4	5	5	72	84

Remaining eggs dissected 21st June and found to be dead.

*B*2.—82 eggs, 28 of which were more or less shrunken, were immersed after 7 days' drying on the 20th April.

Lot *B*2.	Date of hatching.														Total which hatched.	Percentage which hatched.
	April.		May.				June.									
	21	28	12	19	20	21	5	10	11	12	14	16	18	19		
Immersed 20th April...	35	...	...	1	...	2	...	...	6	...	...	...	...	...	44	54

The remaining eggs and eggshells of Lot *B*2 were counted and carefully examined on the 5th July:—

59 had uncapped,
3 had collapsed,
8 apparently sound eggs were dissected:—6 contained *living* larvæ, 1 a dead larva, 1 was infertile.

The remaining more or less shrunken eggs contained dead larvæ.

The only feasible way of accounting for the discrepancy between the larval record and the shells is to suppose that, although a number of the eggs uncapped, the larvæ failed to get free, a by no means unusual occurrence, but the number (15) in this instance, is rather high, in relation to the size of the batch.

Remarks and Notes.

On the 28th April and the 12th, 19th and 20th May, the pans containing the eggs were placed in an ice chest, the temperature of the water falling about 10° F.

On the 20th May, after the cooling, both lots were dried:—

Of *B*1, 31 eggs retained their full shape.
,, *B*2, 11 ,, ,, ,,

Both lots were again immersed and put out of doors for the night to cool the water.

On the 3rd June both lots were again dried :—

Of *B*1, 36 eggs retained their full shape.

,, *B*2, 13 ,, ,, ,,

Both lots were again immersed.

On the 5th June and following days the pans were placed out of doors each evening so that the water might be cooled at night.

Experiment No. XIX.

AGITATION OF THE WATER AS A FACTOR IN HATCHING.*

Mitchell (1907) states that Dupree found agitation to be a factor in the hatching of ova of species of mosquitoes other than *Anopheles*, which deposit their eggs singly.† It was noticed that disturbance of water in which eggs were placed was coincident with the appearance of newly hatched larvæ of *S. fasciata*, but the phenomenon, being only of occasional occurrence, was rejected as a cause of hatching, in favour of the view that the agitation merely made larvæ that had been recently hatched show themselves, trial stirrings giving no consistent results. Upon reading Mitchell's statement, the following experiments were carried out :—

> A batch of eggs laid 4 or 5 weeks previously, which had been dry for 3 weeks, was placed in water—temperature about 73° F. 150 to 200 hatched within a few minutes, and by next morning 50 to 70 more larvæ were out. After an interval of 6 or 8 hours, during which none of the remaining eggs hatched, the water was agitated by shaking. 1 larvæ emerged and died. After a period of 20 hours, during which no more eggs hatched, the water was again agitated by a violent shaking. None of the eggs hatched. After 28 hours the water containing the eggs was placed out of doors to try the effect of cooling—none of the eggs hatched.

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* Experiments now in progress show that the contamination of water in which the eggs are lying has a marked effect on their hatching. Two trials performed since the MSS. went to press will serve to illustrate this clearly.

Into each of two glass pans, containing 100 cc. of tap water at 65° to 70° F., was placed one half of a slip of paper with upwards of 400 eggs of *S. fasciata* on it, there were approximately 200 eggs in each pan. To one pan (*A*) was added 3 cc. of water from a beaker which had been allowed to incubate at 97° F. for 48 hours with a fragment of human fæces in it. This water was thick and brown with the characteristic smell. To the other pan (*B*) nothing was added.

After 4 hours 14 larvæ had emerged in pan *A*, none in *B*.

,, 20 ,, 127 ,, were swimming ,, *A*, and 6 ,, *B*.

,, 70 ,, 136 ,, ,, ,, ,, *A*, ,, 42 ,, *B*.

The experiment was repeated, using fresh horse dung in place of human fæces.

No larvæ emerged in the first hour.

After 18 hours 148 larvæ had emerged from the eggs in pan *A* (contaminated water) and 11 in pan *B* (tap water only).

3 cc. of the manure water was then added to pan *B*. After 18 hours 159 larvæ had emerged, the stage of their growth suggesting that they had emerged within an hour or two of the addition of the manure water.

Further and more exact experiments with sterilized eggs and fluids are now being carried on by Dr. E. E. Atkin and myself. These, while supporting the above tests, suggest that the results are due to bacterial action. Under certain conditions eggs will not hatch while the fluid in which they are immersed remains sterile, but the infection of the fluid with bacteria causes the larvæ to emerge within a few hours.

† "Mosquito Life" (Page 26). Evelyn Groesbeeck Mitchell. G. P. Putnam & Sons, New York and London, 1907.

Time did not permit of the experiment being followed further. A second trial was made with a large batch of eggs laid 4 months previously. The batch was divided into two portions; both lots were immersed in beakers containing 200 cc. of water. Hundreds of larvæ emerged within a few hours. After 24 hours had elapsed, hatching had declined to a minimum and 6 hours later, no larvæ having emerged in either beaker, one of them was vigorously shaken while the other was placed out of doors for the night. Next morning 8 larvæ had emerged from the eggs in the cooled beaker; none had emerged in the one which had been shaken. The shaking and cooling were repeated 48 hours later, but none of the eggs hatched, and a later repetition was also ineffectual in both cases.

Time did not permit of the experiment being carried further. These trials cannot be considered as conclusive, but they suggest, if Experiments Nos. XIV. to XVI. are also taken into account, that agitation, if a stimulus to hatching, is less effectual in compelling larvæ within the eggs, which have not yet reached their hatching zone or period, to emerge, than cooling.

Experiment No. XX.

EXPERIMENTS RELATING TO THE PERIOD DURING WHICH THE EGGS OF *STEGOMYIA FASCIATA* RETAIN THEIR VITALITY WHEN OUT OF WATER.

The eggs laid on a filter paper or fallen leaves of the cottonwood tree were placed in wire gauze tubes or paper envelopes. In some cases, after the paper envelopes were placed in wire gauze tubes, these were again covered with paper in an attempt to exclude small predatory insects, such as ants, which could get through the mesh of the wire gauze. In spite of all precautions, however, the intended comparative statistical form of the experiments was vitiated owing to the ravages of one of the *Psocidæ* (book lice), a species belonging to the genus *Clothilla*. In many cases only a few out of hundreds of eggs stored remained to be tested, while in experiments where the destruction was less obvious it was impossible to form any estimate of the percentage of mortality due to long storage, apart from the attacks of these insidious little foes. As a consequence, the experiments only afford evidence of the period during which the eggs remain viable under various conditions, and not of the percentage which survive.

The tests were designed to fall into two Sections: (*A*) in which the eggs were exposed to the weather, and (*B*) where they were under cover. This plan had to be modified, however, to prevent the loss of eggs due to their being washed away by heavy rain, or to their hatching in small accumulations of water on the leaves or paper on which they rested.

During the dry season the tubes containing the eggs in Section *A* were not sheltered from sun or rain. An examination early in March showed that where paper coverings were used they had been eaten into holes by snails and millipedes, while both ants and *Psocidæ* had penetrated into the envelopes containing the eggs. In cases where no envelopes or paper coverings to the tubes had been used, many of the eggs had either fallen off or had been washed off by late rains, and in a number of cases eggs had hatched. With the oncoming of the rains further instances of eggs hatching on wetted paper

occurred, and it was found necessary to cover the eggs with inverted tins to guard against further flooding.

In a few instances only was it possible to follow up separately the larvæ which hatched from different batches. Where time did not permit of this they were turned into a common breeding pan, from which large numbers of normal adults were reared. The tests dealing with the viability of the eggs were carried out in the same places as those dealing with the length of adult life. Charts giving curves of temperature and humidity for these situations will be found, with short descriptive notes, in the Experimental Series No. XXXV., on pages 64 and 92 to 101.

Section *A*.

Pen in Hospital Compound.

Eggs laid on leaves and filter paper, not placed in envelopes and tube not covered with paper—only a few eggs remained to be tested :—

Batch 1.—Laid during December; immersed 18th June. 1 hatched within 24 hours, two or three others emerged within the next two or three days; one of these died in its first skin shortly after emergence.

Vitality retained for 170 *to* 180 *days.*

Batch 2.—Laid during December, immersed 18th June. 1 hatched on the 18th, 1 on the 19th, 1 on the 20th and 1 on the 21st.

Vitality retained for 170 *to* 180 *days.*

One of the larvæ pupated on the 6th day after immersion; a male and a female emerged on the 8th day. Other specimens emerged later; the last to emerge was a male which took 11 days.

Eggs laid during January, on filter paper and placed in an envelope were also immersed on the 18th June, but failed to hatch.

Under Pen in yard at 26, Westmoreland Street.

Laid on leaves and filter paper, not placed in an envelope and the tube not covered with paper until commencement of the rains :—

Batch 1.—Laid during December, immersed 20th June. 2 hatched on the day after immersion; 1 larva died within an hour or two; three or four were hatched within the next few days.

Vitality retained for 175 *to* 180 *days.*

Batch 2.—Laid during December; immersed 23rd June. None hatched on the day of immersion, but several on the succeeding days.

Vitality retained for 175 *to* 180 *days.*

Two males and one female emerged within 7 days of the immersion of the eggs and two females on the 8th day.

Batch 3.—Eggs laid during January, on filter paper placed in an envelope which was kept in a paper-covered tube. Only 36 out of several hundred eggs remained. Immersed 23rd June; 7 hatched next day, 7 on the second and 2 on the third day.

Vitality retained for 145 *to* 150 *days.*

Development of larvæ not recorded.

On Ground in Mosquito House.

Laid during December on leaves and filter paper, not placed in an envelope and the tube not covered with paper until the commencement of the rains.

Immersed 13th July; one hatched the following day; no more emerged during the week that the trial was continued.

Vitality retained for 195 *to* 200 *days.*

Eggs laid on filter paper and placed in an envelope which was kept in a paper covered tube:—

Immersed 13th July.

1 hatched within 24 hours.
2 ,, ,, 48 ,,
4 ,, ,, 72 ,,
1 ,, ,, 120 ,,

Vitality retained for 165 *to* 170 *days.*

Eggs laid during December on filter paper and placed in envelopes, but not placed in tubes or again covered with paper:—

(1) A batch of eggs laid during December on filter paper was placed in water for 24 hours and the eggs which *did not* hatch were dried and stored.

Immersed 20th July.

1 hatched within 2 hours.
7 ,, ,, 48 ,,
2 ,, ,, 72 ,,
2 ,, ,, 120 ,,

Vitality retained for 200 *days.*

(2) Laid during December on filter paper and stored in an envelope without previous immersion.

Immersed 20th July.

53 hatched within 2 hours, 7 larvæ died within a few hours of hatching.
165 ,, ,, 24 ,, , 12 larvæ died within a few hours of hatching.
52 ,, ,, 48 ,, , 4 larvæ died within a few hours of hatching.
24 ,, ,, 72 ,,
3 ,, ,, 96 ,,
2 ,, ,, 120 ,,

Vitality retained for 200 *days.*

(3) Laid during December on filter paper and stored in an envelope without previous immersion.

Immersed 20th July.

20 hatched within 2 hours.
6 ,, ,, 24 ,,

Vitality retained for 200 *days.*

SECTION *B*.

Eggs Stored in Pit in the Mosquito House.

Laid during December on leaves and filter paper, not placed in envelope, tube uncovered :—

Immersed 6th July.

(1) 1 hatched within an hour.

Vitality retained for 187 *days.*

(2) Laid 7th to 14th December.

Immersed 6th July.

1 hatched within an hour.
4 ,, ,, 24 hours.
3 ,, ,, 48 ,,
1 ,, ,, 72 ,,

Vitality retained for 204 *days.*

Laid on filter paper during January, placed in an envelope which was kept in a paper covered tube.

Immersed 6th July, but failed to hatch.

Eggs laid on filter paper and kept in paper envelopes in the animal house until 31st December, then stored in the mosquito house pit :—

(1) Laid 20/23 October. Immersed 21st May.

About one dozen eggs of full and sound appearance remained.

2 hatched within 2 hours.
1 ,, after 17 days' immersion.
5 ,, ,, 20 ,, ,,

Vitality retained 210 *days.*

(2) Laid 24/26 October. Immersed 6th July.

Only 6 eggs of full and sound appearance remained out of about 100 stored ; there were many collapsed eggs, and signs of attack by *Psocidæ* were evident. None of the eggs hatched during a period of 10 days' immersion. On dissection, 1 living larva and 2 dead ones were extracted, the other 3 eggs collapsed while in the water.

Vitality retained 260 *days.*

(3) Laid during November. Immersed 25th July.

1 hatched within 48 hours.
1 ,, ,, 6 days.

Vitality retained 240 *days.*

Eggs laid on filter paper and kept in paper envelopes in the animal house until 31st December, then placed on ground in mosquito house under an inverted tin :—

Laid 29th October—5th November. Immersed 14th July.

1 hatched within 24 hours.

Vitality retained 250 *days.*

No more hatched during 10 days' immersion. On dissection a number of eggs were found to contain dead larvæ.

A tin containing leaves and filter paper on which eggs had been laid during January was left open on the Laboratory bench from January until the end of June ; it was then filled with water—11 adults were reared.

Vitality retained for 140 *days.*

An attempt was made to test the effect of exposure to the sun on eggs laid in tins and on leaves lying in tins. They were placed on the ground under a wire gauze pen in a part of the hospital compound which received full sunlight from 10 a.m. to 4 p.m. The eggs were laid in December and the exposure commenced on the 31st of that month, but the experiment came to an untimely end in January owing to the curiosity of the son (aged 5) of a German prisoner (his mother was a patient in the Hospital).

A second attempt was made after his departure in February. Three tins and a glass jar in which eggs had been laid during January, either on the sides or on dead leaves contained in them, were exposed. Water was poured into these receptacles on the 5th June.

Eggs hatched in one of the tins only, and several *Stegomyia fasciata* were reared by the middle of June.

Viability of Eggs of *Stegomyia fasciata* laid in Sierra Leone and brought to England.

Eggs from all these batches had been tested from time to time in Freetown and viability had been proved for from 4 to 6 months.

Laid	20th to 23rd Oct.,	1914.	Immersed	1st Sept.,	1915.	Failed to hatch.
,,	24th to 26th	,,	,,	,,	,,	,, ,,
,,	26th to 29th	,,	,,	,,	,,	,, ,,
,,	5th to 13th Nov.	,,	,,	,,	,,	,, ,,

Laid 15th January, 1915. Immersed 16th Sept., 1915. Two hatched within 24 hours.

This was a large batch laid on filter paper, which had become so firmly attached to the tin sides of the breeding pan that on drying it could not be detached without scraping. The tin was cut up and portions with the undisturbed eggs on them were immersed. The two eggs that hatched only represent a small percentage of the eggs tested; certainly not more than 2 per cent.

Laid June-July, 1915. Immersed 16th September, 1915. Hatched freely.

Laid during July, 1915, on wood. Immersed 20th October, 1915. Hatched freely within 2 hours of immersion.

Laid during January on filter paper that became firmly attached to the side of a tin. Immersed 20th October, 1915. Hatched freely within 2 hours of immersion. *Vitality retained for* 262 *days.*

Experiment No. XXI.

TEMPERATURES WHICH EGGS OF *STEGOMYIA FASCIATA* ARE ABLE TO WITHSTAND.

It was found at Freetown that eggs easily survived a day or two at blood heat, 97° F., but more extreme tests were not practicable.

The following tests were carried out at the Lister Institute:—

First Test.

Eggs laid June–July, 1915, at Freetown on slips of filter paper and brought to England in a wooden box.

A slip was divided and one portion was kept in an incubator at 105·8° F. for 48 hours; the other portion was kept at room temperature, 65° to 70° F. On immersion the eggs on the slip placed in the incubator failed to hatch, while those on the control slip hatched freely.

Second Test.

A slip was divided into four, and the eggs on the several portions were submitted to the following conditions for 24 hours, the eggs submitted to heat were placed in a moist cell. At the expiration of the 24 hours all were immersed in water at about 64° F.

	After immersion at 64° F.		
	2 hours.	24 hours.	72 hours.
Incubator at 107·6° F.	...	...	...
Hot room at 96·8° F.	1 hatched	40 per cent. hatched.	70 per cent. hatched.
Incubator at 78° F. ...	A number	70 ,, ,,	75 ,, ,,
Cold room at 28° F. ...	1 hatched	20 ,, ,,	25 ,, ,,

Third Test.

A large batch of eggs laid during June and July in Freetown were placed in the cold room of the Lister Institute on the 18th September, and submitted to a temperature of 28° to 30° F. for 25 days; they were then placed in water at 65° F., subsequently raised to 75° F.; none hatched, but eggs of a control batch, kept at 65°–70° F., did so.

Fourth Test.

A batch of eggs laid on filter paper in London by specimens reared from Freetown eggs was divided into four lots; these were kept for 24 hours at 29°–30° F., 75° F., 95° F., and 102° F. respectively They were then placed in water at 65° F. and gradually raised to 75° F. after 20 hours' immersion. Of the lot submitted to—

29°–30° F.,	50 out of	69 hatched	= 72 per cent.	(one larva died).
75° F.,	6 ,,	50 ,,	= 12 ,,	
95° F.,	10 ,,	53 ,,	= 19 ,,	
102° F.,	none ,,	50 ,,		

The pans of water containing the eggs were then allowed to cool down to 65° F. and examined after 4 hours. Of the lot submitted to—

29°–30° F.,	6	had hatched	= 9 per cent.
75° F.,	20	,, ,,	= 40 ,,
95° F.,	none	,, ,,	
102° F.,	1	,, ,,	= 2 ,,

The pans were again kept at 75° F. and examined after 76 hours. Of the lot submitted to—

29°–30° F., none had hatched.
75° F., 2 " " = 4 per cent.
95° F., 1 " " = 2 "
102° F., 3 " " = 6 " (and were dead).

The pans were again allowed to cool to 65° F. and left. Of the lot submitted to—

29°–30° F., none had hatched.
75° F., 3 " " = 6 per cent.
95° F., 1 " " = 2 "
102° F., none " "

The pans were again placed at 75° F. and examined 20 hours later. Of the lot submitted to—

29°–30° F., none had hatched.
75° F., 8 " " = 16 per cent.
95° F., none " "
102° F., 1 " " = 2 "

The pans were again allowed to cool to 67° F. and left for 4 hours Of the lot submitted to—

29°–30° F., none had hatched.
75° F., 1 " " = 2 per cent.
95° F., 3 " " = 6 "
102° F., 1 " " = 2 "

No further hatching occurred within a period of 4 days.

Result.

Temperature to which eggs were submitted for 24 hours.	Number of eggs tested.	Hatched within 128 hours.
29°–30° F.	69	56 = 81 per cent.
75° F.	50	40 = 80 "
95° F.	53	15 = 28 "
102° F.	50	6 = 12 "

Fifth Test.

Effect of heat *before* incubation.

A batch of eggs that had been laid not more than fifteen or sixteen hours was submitted to 97° F. for thirty minutes. The batch was then divided, half the eggs were subjected to a further rise of temperature to 114·8° F. for thirty minutes. Both lots were then stored dry for a few days at about 65° F. and then placed in water. All the eggs heated to 114·8° F. completely collapsed, and no larvæ emerged, while most of the control eggs hatched.

Experiment No. XXII.

ENEMIES IN THE EGG STAGE.

Under natural conditions there are probably many more enemies of this stage than appear when the eggs are stored under artificial conditions and protected against the attacks of vertebrates and the larger insects.

It is likely that some species of small bird may search out and devour the eggs in a similar manner to the Tits which destroy such multitudes of eggs of the winter moths in Northern Europe. Predaceous beetles and beetle larvæ possibly take toll, but no actual evidence of any of these attacks was forthcoming.

In captivity eggs stored out of doors were lost owing to the disturbing action of millipedes and woodlice, which gnawed the paper on which the eggs were laid, and to which they were somewhat loosely attached, but here again neither observation nor circumstantial evidence suggested differential action of such large enemies, which should have been apparent if the eggs were used as food. The same kind of loss to stored eggs occurs when they are laid on leaves, though this is probably chiefly due to bacterial action rotting the surface of the leaf in damp weather.

Ants might be expected to seek out and carry off the eggs, but all the evidence both general and experimental is entirely negative. It seems almost certain that the eggs must in some way be rendered distasteful to them, otherwise it is impossible to understand how the species of mosquitoes which rely on drought resisting eggs to tide over the dry season, could possibly survive in the face of the omnipresent activity of these insects in their search for food.

Indifference alone is hardly a sufficient reason for the passing over of eggs by a species of ants, one of which was detected in the act of laboriously carrying away a shred of aluminium foil.

The disappearance of eggs from boxes with such close-fitting lids that no ant could enter contrasted with the fact that they might be left uncovered on the Laboratory bench for days without interference, although ants were continually searching for and carrying away dead insects or any dried scraps of insects that might be about. This led to the following experiments, which prove conclusively that a species of *Psocidæ* (book lice), apparently the same species which occurs in Europe, was the enemy which had wrought such extensive destruction among the experimental eggs. It was found in nearly every situation, both indoors and out, which afforded sufficient cover. The *Psocidæ* themselves are attacked and utilized as food by a species of *chelifer*, or false scorpion.

Into a glass-topped entomological box, which contained remnants of dead mosquitoes and a numerous brood of *Psocidæ*, were placed two slips of paper on which eggs had been laid. On No. 1 the eggs had been laid and allowed to dry a month previously; at the commencement of the test there were 20 full eggs and 2 collapsed ones on it. On No. 2 the eggs had been laid and dried 5 months previously; examination showed that there were 14 full, 10 shrunken and 3 collapsed eggs on it.

On the following day, No. 1 had 13 full and 2 collapsed eggs on it, while No. 2 had 4 full, 8 shrunken and 2 collapsed eggs. There were also

fragments of partly eaten eggs, and a careful examination showed that 2 of the apparently undisturbed eggs had small holes gnawed in them.

By the third day, in No. 1 there remained 4 full and 2 collapsed eggs, and in No. 2 but 1 full egg and some partially eaten remnants.

On the fifth day nothing but fragments of shell remained, which were shortly devoured, a special feature of the work of the *Psocidæ* being the completeness with which they clear up if time permits, not even the tiniest fragment of shell being left to afford evidence of the nature of the attacking agent.

The next test was to place a small batch of freshly laid eggs in the box. On drying there were found to be 22 full and 2 collapsed eggs. Two days later not a vestige of the eggs remained.

The third test was a comparative one. A large batch of freshly laid eggs was dried and the collapsed eggs removed, it was then divided into two portions.

Lot 1, consisting of 82 eggs, was placed in the box.

Lot 2, consisting of 67 eggs, was placed on the Laboratory bench, and left uncovered except on two occasions. On the 3rd of June a chip box was accidentally placed over the paper slip on which the eggs had been laid. On the 4th June the paper was turned over so that the eggs were between the paper and the bench. In both instances the accidental covering led to attack on the eggs.

LOT 1.

82 Eggs placed in Box containing numbers of Psocidæ.
Record of Reduction in Numbers.

May.			June.											
26	28	31	3	4	5	6	7	8	9	10	11	12	13	15
82	77	76	68	61	54	47	43	28	17	8	5	3	1	0

LOT 2.

67 Eggs left exposed on Laboratory Bench.
Record of Reduction in Numbers.

May.			June.											
26	28	31	*3	*4	5	6	7	8	9	10	11	12	13	15
67	67	67	45	42	42	42	42	42	42	42	42	42	42	42

* On the 3rd and 4th June the eggs were covered.

On the 15th June Lot 2 was transferred to the box.
After 24 hours only 20 eggs remained.
After 72 hours only 1 full, 1 shrunken and 1 collapsed egg remained.

(*B*) LARVÆ AND PUPÆ.

Experiments Concerning the Description and Quantity of Food needed by Larvæ of *Stegomyia fasciata*

General Notes.

The high mortality which occurs when the captured larvæ are simply placed in jars of water to rear, combined with the experience gained in breeding mosquitoes from the egg, show that an ample store of organic matter in the water to start with, or the addition of fresh food at intervals is essential. The description of organic matter used may vary within wide limits. Dead leaves, boiled white of egg, rice or other grain, dead insects, fæces, etc., all give good results provided the quantity is adjusted to the number of larvæ and quantity of water. Oily or fatty foods (such as cockroaches) may, however, easily cause a high or even a total mortality. So long as the water is free from oil or fat it may be very foul, cloudy or thick, and swarming with bacteria to an extent which suggests a broth culture. In the case of rice the water was so thick in some of the experiments as to resemble thin starch. Dead insects and other small animals, together with leaves, probably afford the chief natural sources of nourishment for the larvæ of *Stegomyia fasciata* and most of its relatives as well ; but apart from these, the fall of organic dust on any uncovered area would most likely suffice for a limited number of larvæ to attain the adult stage.

With *Stegomyia* and, so far as a limited experience goes, other *Culicine* mosquitoes, competition for the available food supply is very keen. To obtain a start before other organisms have had time to develop is an evident necessity if large broods are to be reared. Any quantity of fresh food added to standing water will not reproduce the favourable conditions which obtained at the initiatory filling of the breeding pool. This may be observed under

natural as well as artificial conditions, and is probably largely due to the killing of the newly hatched larvæ by the larger ones, as pointed out by MacGregor (1915).

Stegomyia with its resting eggs, some of which are ready to hatch within a few minutes, and others within two or three hours of immersion, is better adapted to take full advantage of the late and early rains than species which have to deposit eggs requiring some 30 hours' incubation, after the pool has formed. Apart from such obvious competitors for food as tadpoles, ephemerid larvæ and those of species of *Chironomus* or other omnivorous water insects, a species of *Ostracoda* belonging to the genus *Cypris* is a highly successful competitor if it gets a start in breeding pans. Once it is established, few, if any, of the mosquito larvæ get sufficient food to finish their development.

Pans or jars, the sides of which become green with the growth of *Algæ*, are also very generally impossible for further breeding, but whether or no this is due to the *Algæ* or some secondary cause is undetermined.

The first moult is not passed by larvæ put into clean but unfiltered tap water. In the absence of added organic matter the larvæ seem unable to pass to the second skin until the death of some of their fellows provides the survivors with nutriment. If after a short but sharp period of starvation abundant food is given, the mortality may be low, and the larvæ reach maturity quickly, but produce small adults. On the other hand, if the period of scarcity is continued, the mortality is high, and the larval life may be unduly prolonged, possibly up to seventy days.

Under the most favourable conditions the larval life may be passed within four days, and males have completed their development within five days five hours.

The fact that larvæ breeding in water containing little organic matter produce small adults* has its practical side when cleanly tanks and covered cement-lined cisterns replace wooden butts or other dirty storage receptacles. The covers need to be of a smaller mesh, not less than 18 × 18 to inch, because in addition to the possibility of these dwarf females getting through the netting

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* See also under "Enemies," page 79.

when seeking water to lay their eggs, there is always the risk of eggs that have been deposited in gutters being washed in through the netting and producing small sized specimens, which will squeeze through netting they would not otherwise pass in an endeavour to get out.

Protracted development or lagging may occur even in the presence of an abundant food supply; a few larvæ of any given batch will frequently lag behind their fellows. These lagging larvæ are often unhealthy and die, but they sometimes complete their development and produce normal adults after three or four times the usual period.

When considering the experiments some allowance must be made in respect of sex, the early males being usually a day quicker in their development than the females.

All the experiments with larvæ were performed in the Laboratory of the Colonial Hospital, and a Chart (No. 1) embodying the records of temperature and humidity from December, 1914, to July, 1915, is appended. A partial record of the maximum and minimum temperature and extremes in each week from September 11th to December 4th is set forth in Chart No. 9 on page 101.

Experiment No. XXIII.

QUANTITY AND NATURE OF FOOD REQUIRED.

200 cc. of tap water was put into each of three beakers.
To N.R. ·2 gr. of uncooked native rice was added.
To P.R. ·2 gr. of uncooked polished rice was added.
To W.E. ·2 gr. of hard boiled white of egg was added.

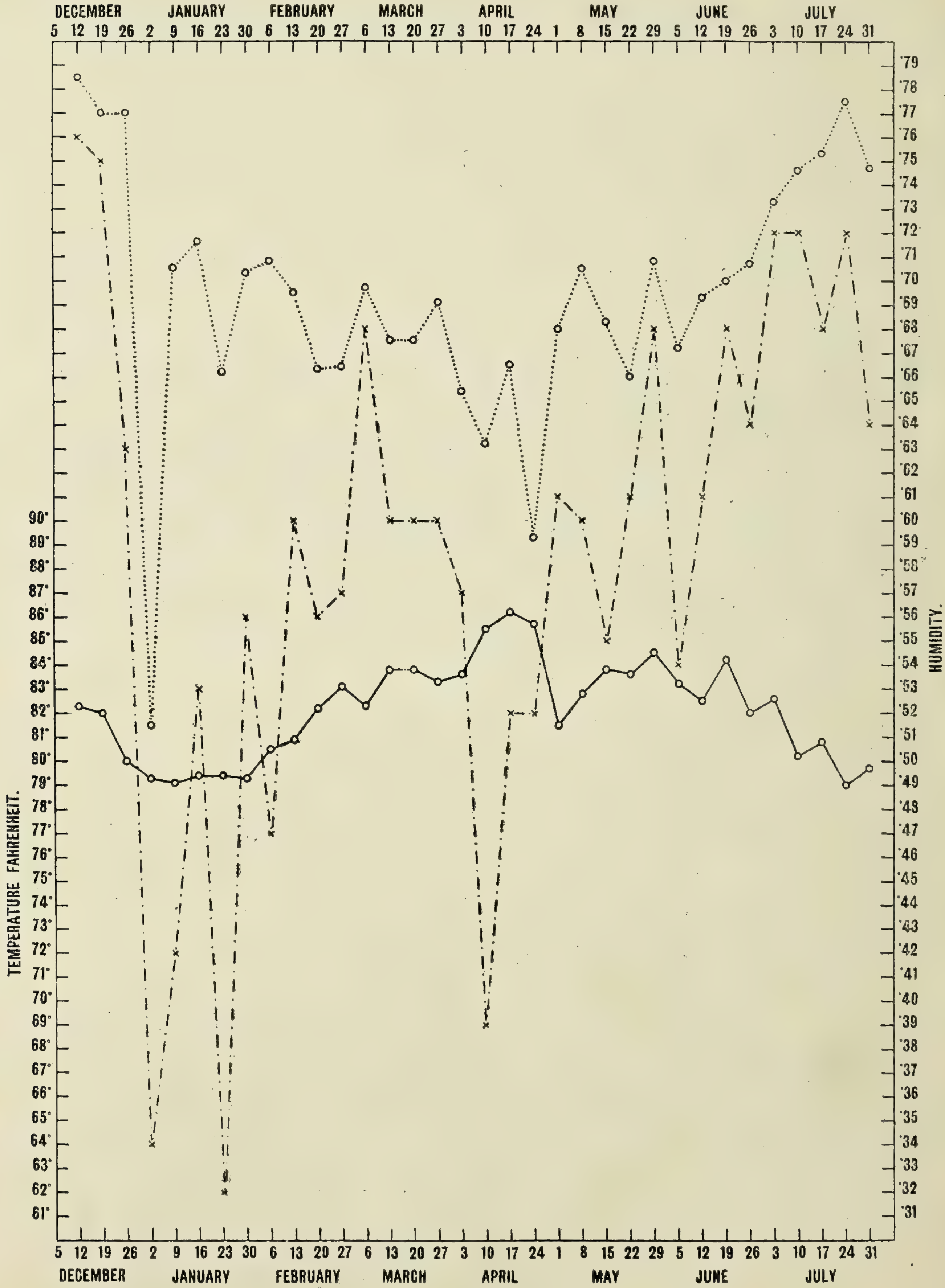
12 larvæ just out of their eggs (from a batch of eggs which had been dried and then re-immersed) were put into each beaker, and these were covered with thin cotton to exclude dust and small insects.

The temperature in the Laboratory during the course of the experiment averaged about 82° F.

2nd day after start—All the larvæ were of about equal size.
3rd ,, ,, ,, N.R. and P.R. ahead of W.E.
4th ,, ,, ,, P.R. most advanced; N.R. next, with W.E. a bad third, but all seemed equally healthy.
6th ,, ,, ,, P.R., 5 already in pupal stage; N.R., larvæ full-grown, but no pupæ; W.E., almost all the larvæ a moult behind.

CHART No. 1.

CURVES OF TEMPERATURE AND HUMIDITY IN LABORATORY AT COLONIAL HOSPITAL, FREETOWN.



Observations at 9 a.m. each day :—

Temperature———————   Humidity, ...

Minimum Humidity record in each week — · — · — · — ·

FINAL RESULT.

Lot.	Number of adults reared.	Time occupied from hatching to adult state.			Mortality.	Remarks.
		Shortest.	Average.	Longest.		
N.R.	9 males, 2 females	9 days	10 days	12 days (1 female)	8 per cent.	...
P.R.	6 males, 6 females	8 days	9 days	11 days (2 females)	Nil.	...
W.E.	1 male, 6 females	26 days	31 days	42 days (1 female)	42 per cent.	...

The quantities of food used are not, of course, equivalent, as the water content of the white of egg will be much greater than that contained in the rice.

Experiment No. XXIV.

QUANTITY AND NATURE OF FOOD REQUIRED.

200 cc. of tap water was put into each of two beakers.
To P.R. 0·5 gr. of desiccated polished rice was added.
To W.E. 0·5 gr. of desiccated boiled white of egg was added.
16 larvæ, which had just emerged from eggs of the same batch as those used in the last experiment, were put into each beaker, and these were covered with thin cotton to exclude dust, etc.
The Laboratory temperature during the course of the experiment averaged about 82° F.
The larvæ in P.R. gained rapidly on those in W.E. at first, but subsequently the W.E. batch recovered most of the lost ground.

FINAL RESULT.

Lot.	Number of adults reared.	Time occupied from hatching to adult state.			Mortality.	Remarks.
		Shortest.	Average.	Longest.		
P.R.	10 males, 6 females	8 days	8 days	9 days (5 females)	Nil.	...
W.E.	10 males, 5 females	8 days	9 days	11 days (2 males)	6 per cent.	1 pupa died on the 13th day.

In this and the following experiments the food material was dried or desiccated before use.

Experiment No. XXV.

QUANTITY AND NATURE OF FOOD REQUIRED.

200 cc. of tap water was put into each of four beakers.

To O. nothing was added.

To P.R.O., 0·5 gr. desiccated polished rice was added.

To W.E.O., 0·5 gr. desiccated boiled white of egg was added.

To C.W.L., 1·0 gr. dried fragments of fallen cottonwood leaves was added.

20 larvæ just emerged from a large batch of eggs of mixed parentage, which hatched in response to cooling, were put into each. The beakers were covered with thin cotton to exclude dust, etc.

The temperature in the Laboratory at 9 a.m. during the course of the experiment averaged 79·4° F.

1st day :—No noticeable difference.

2nd day :—O., very little growth, no moults.
- P.R., in second skin.
- W.E., a few in third skin, but most in second skin.
- C.W.L., far in advance of the others. Mostly well-grown in third skin, and a few approaching the third moult, but 2 larvæ still in first skin.

3rd day :—O., about half have grown, the remainder show no growth.
- P.R., mostly full-grown in third skin, but a few only just past the moult.
- W.E., mostly full-grown in third skin, but a few only just past the moult.
- C.W.L., still ahead, but the gap between this batch and P.R. and W.E. is lessening. None have yet reached the fourth skin, but a few are preparing to moult; 2 still lag, they are now in second skin.

4th day :—O., all are now making progress in the first skin.
- P.R., all are well-grown in fourth skin, except 2, one of which is in the second skin and the other in the third skin.
- W.E., all but 3 are well-grown in fourth skin; of the laggards, 2 are in the third and 1 in the second skin.
- C.W.L., are mostly marking time, but the backward larvæ are progressing; one is in the second and the other in the third skin.

5th day :—O., still in first skin; little appreciable further progress.
- P.R., 3 have pupated; 2 larvæ are still in third skin; the remainder are full-grown.
- W.E., 1 living and 1 dead pupa; 2 larvæ in third skin; the remainder full-grown.
- C.W.L., 6 pupæ, 1 larva in third and 1 in second skin; the remainder full-grown.

6th day :—O., still marking time in first skin.
- P.R., 16 pupæ, 1 full-grown larva and 1 in third skin.
- W.E., 6 pupæ, several larvæ dead; the remainder full-grown.
- C.W.L., 13 pupæ, 1 larva in third and 1 second skin; the remainder full-grown.

7th day :—O., still no progress.
P.R., 18 pupæ and 2 larvæ, 1 in third skin.
W.E., 9 pupæ, two or three more larvæ dead.
C.W.L., 5 adults, 9 pupæ and 4 larvæ, 1 still in second skin.

8th day :—O., only 16 larvæ living; two or three of these have moulted and are now in second skin.
P.R., 13 adults, 2 pupæ and 2 larvæ, 1 still in third skin.
W.E., 4 adults, 6 pupæ and 1 larva.
C.W.L., 5 adults, 4 pupæ and 4 larvæ, 1 still in second skin.

12th day :—O., 12 living larvæ, the largest backward in the second skin; the smaller ones still in the first skin.
P.R., finished.
W.E., 1 still in larval stage.
C.W.L., 3 still in larval stage; 1 only in third skin.

17th day :—O., 11 living larvæ, slight growth, but no moults since 12th day.
W.E., the last larva has now pupated.
C.W.L., 1 larva has pupated and an adult reared; the 2 remaining larvæ are both in fourth skin.

Final Result.

The larvæ of O. gradually died off, leaving a single survivor, which pupated after spending 48 days in the larval stage. A female specimen was reared. The larvæ did not kill one another, but lived on the decaying bodies of their fellows as they died.

Lot.	Number of adults reared.	Time occupied from hatching to adult stage.			Mortality.	Remarks.
		Shortest.	Average.	Longest.		
O. ...	1	50 days	...	...	95 per cent.	...
P.R....	16	8 ,,	8 days	9 days	20 ,,	1 larva died on 16th day.
W.E.	10	8 ,,	9 ,,	13 ,,	50 ,,	1 pupa died on 18th day.
C.W.L.	16	7 ,,	9 ,,	15 ,,	20 ,,	1 pupa died on 21st day.

When considering these results it is necessary to bear in mind three points:—

(1) the *quantity* of *organic matter* in relation to (2) the *quantity* of *water*, and (3) the number of larvæ in relation to both.

The result of O. affords further evidence of the result of insufficiency of food, but in a more acute form than W.E. in Experiment No. XXIII.

The mortality in P.R., as compared with the absence of deaths when the larvæ were fed on polished rice in the two earlier experiments, is probably not

due to any scarcity of food owing to the larger number of larvæ present, but either to overcrowding or pure chance.

With W.E. in this experiment, the increased mortality, as compared with the use of the same food in Experiment No. XXIV., is also explicable as the result of overcrowding or chance.

With C.W.L., however, the result should be studied in relation to the use of fallen leaves of the cottonwood tree in the later experiments, the suggestion clearly being that the quantity of food used was barely sufficient for the number of larvæ, though the mortality may have been influenced, as in P.R. and W.E., by overcrowding.

Experiment No. XXVI.

ASSIMILABILITY IN ADDITION TO QUANTITY AND NATURE OF FOOD.

This experiment was planned with a view to ascertaining if speed of growth depended upon the assimilability of food apart from its nature. It was hoped also that some evidence of the action of bacteria or other micro-organisms in relation to this process might be obtained.

Into six beakers were placed the following food materials, all of which had been dried for a week in the desiccator :—

P.R. 1, 0·5 gr. polished rice.
P.R. 2, 0.5 gr. „ „
C.W.L. 1, 0·5 gr. fragments of fallen leaves of the cottonwood tree.
C.W.L. 2, 0·5 gr. „ „ „ „ „
E.L. 1, 0·5 gr. fragments of fallen leaves of a species of eucalyptus.
E.L. 2, 0·5 gr. „ „ „ „ „

To beakers P.R. 1, C.W.L. 1, and E.L. 1, 200 cc. of tap water was immediately added.

All six beakers were covered with thin cotton to exclude dust.

The temperature in the Laboratory at 9 a.m. during the course of the experiment averaged 81·5° F.

After 24 hours a microscopic examination of the water was made by wet film.

P.R. 1, showed a few slowly moving rounded cells (? yeast).
C.W.L., a few bacteria and infusoria in each field.
E.L., no sign of any organism.

After 46 hours a further examination was made.

P.R. 1, showed numbers of bacteria + + + + and some of the slowly moving rounded cells.
C.W.L. 1, showed bacteria, numerous + + + +, also some infusoria.
E.L. 1, „ „ „ + + + „ „

200 cc. of tap water was now added to beakers P.R. 2, C.W.L. 2, and E.L. 2.

A large batch of eggs of mixed parentage was immersed, and from the larvæ which emerged within 90 minutes, 30 were placed into each of the six beakers.

The following history is general, the "lagging" larvæ are not individually noticed.

1st day:—P.R. 1, ahead of P.R. 2, but not to the extent of a moult.
C.W.L. 1, ahead of C.W.L. 2, but to a less marked extent than with P.R.
E.L. 1, very slightly ahead of E.L. 2.

2nd day:—P.R. 1, well-grown in second skin; P.R. 2, a full moult behind.
C.W.L. 1, rather less grown in second skin than P.R. 1.
C.W.L. 2, a moult behind C.W.L. 1; there is, however, less disparity between C.W.L. 1 and 2 than between P.R. 1 and 2.
E.L. 1 and 2 differ but very little from each other; they are both behind the others. None are past the first skin.

3rd day:—P.R. 1, mostly in fourth skin; a few almost full grown.
P.R. 2, more varied in growth; only a few in fourth skin.
C.W.L. 1, the advanced larvæ are about parallel with P.R. 2, but the proportion still backward in third skin is larger.
C.W.L. 2, quite noticeably behind C.W.L. 1, but only as a question of growth, not of moults.
E.L. 1, are slightly in advance of E.L. 2; both are behind C.W.L. 2.

4th day:—P.R. 1, all full grown, except a few laggards, which make very slow progress.
P.R. 2, in fourth skin, but not quite full grown; the laggards of this lot are, however, ahead of those of P.R. 1.
C.W.L. 1, not quite so advanced as P.R. 2.
C.W.L. 2, slightly behind C.W.L. 1.
E.L. 1 and 2, no noticeable difference; both lots behind C.W.L. 2.

6th day:—P.R. 1, 15 or 16 pupæ; one of the lagging larvæ is dead; all the remaining larvæ full grown in fourth skin.
P.R. 2, 8 or 10 pupæ; the lagging larvæ are now growing rapidly; all the others are full grown in the fourth skin.
C.W.L. 1, no pupæ; the larvæ are marking time as though food were failing.
C.W.L. 2, have quite caught up to C.W.L. 1, in fact, they look on the whole better fed, but there are no pupæ.
E.L. 1 and 2, are slightly behind the C.W.L's. in growth; they differ between themselves in that E.L. 2 shows a smaller range of variation in growth.

From this time onwards it became evident that the larvæ which were given leaves as a source of nutriment (C.W.L. 1 and 2, E.L. 1 and 2), had reached the limit of their food supply. Their record continues as a long-drawn-out period spent in marking time, with short spurts of growth as larvæ died, and supplied the survivors with fresh sources of nutriment.

FINAL RESULT.

Lot.	Number of adults reared.	Time occupied from hatching to adult stage.			Mortality.	Remarks.
		Shortest.	Average.	Longest.		
P.R. 1 ...	23	7 days	8 days	10 days	23 per cent.	...
P.R. 2 ...	29	8 ,,	9 ,,	11 ,,	3 ,,	...
C.W.L. 1	3	45 ,,	47 ,,	50 ,,	90 ,,	One larva lived until the 78th day, but failed to pupate.
C.W.L. 2	3	11 ,,	12 ,,	12 ,,	90 ,,	Three larvæ lived until the 47th day, but failed to pupate.
E.L. 1 ...	2	49 ,,	49 ,,	49 ,,	93 ,,	One larva lived until the 66th day, but failed to pupate.
E.L. 2 ...	1	18 ,,	...	...	...	On the 46th day this item of the experiment was terminated by an accident. There were 10 or 11 larvæ living at the time.

It is doubtful if the difference in mortality between the pair P.R. 1 and 2 is of any significance, but the high death rate among the larvæ given leaves is almost certainly the result of insufficiency of food.

The advantage in speed of growth between the pairs during the early days of the experiment, so far as the P.R. and C.W.L. are concerned, was clearly with the larvæ in the beakers where there had been two days for the food to soak and diffuse, or for micro-organisms to develop. With E.L. the difference was slight, which in view of the sparse growth of bacteria in the water in beaker E.L. 1 after 46 hours, is significant of some relation between the growth of bacteria and the assimilability of the food.

That the final advantage tended to be with the lots in which bacterial growth was not given any start in advance of the larvæ appears to suggest that, if bacteria and other micro-organisms are a direct source of food, they abstract a certain amount of nutriment, which is not subsequently recovered when the larvæ ingest them.

Experiment No. XXVII.

PRESENCE OF BACTERIA CONSIDERED ALSO.

This experiment was planned on similar lines to No. XXVI., but was varied as regards the description of food and number of larvæ used, in the hope of getting more nearly into touch with the problem of the

relationship between larval growth and the development of bacteria in the water. An addendum, of which a short account is appended, was undertaken to allow of larvæ and pupæ being dissected to make gut smears, without interference with the breeding averages and mortality percentages in the main experiment.

Into six beakers were placed the following:—

P.R. 1 and 2, each 0·5 gr. polished rice.

C.W.L. 1 and 2, each 0·5 gr. fragments of leaves of cottonwood tree.

C. 1 and 2, each 0·5 gr. fragments of dead cockroach.

All these food materials had been thoroughly dried in a desiccator and coarsely powdered before weighing.

200 cc. of tap water was at once added to P.R. 1, C.W.L. 1, and C. 1.

All six beakers were covered with thin cotton to exclude dust, etc.

The temperature in the Laboratory at 9 a.m. during the course of the experiment averaged 82·2° F.

After three days a microscopic examination of the water for germs was made:—

P.R. 1, showed bacteria + + and a few slowly moving rounded cells (probably yeasts).

C.W.L. 1, showed bacteria + + +.

C. 1, showed bacteria + + + + +.

200 cc. of tap water was then added to P.R. 2, C.W.L. 2, and C. 2, and 10* newly hatched larvæ were placed in each of the six beakers.

1st day:—No moults.

2nd day:—P.R. 1, all but one or two are now in their second skin.
- P.R. 2, many are in their third skin; the remainder in their second skin, but further advanced than any of the P.R. 1.
- C.W.L. 1, mostly in their second skin; one at least is in the third skin.
- C.W.L. 2, none past the second skin; all are distinctly behind C.W.L. 1.
- C. 1, only two or three living larvæ to be seen; these have just attained the second skin.
- C. 2, all dead (probably due to the formation of a thick, greasy scum).

3rd day:—P.R. 1, none past the third skin.
- P.R. 2, a number are in the fourth skin.
- C.W.L. 1 and 2, do not differ noticeably from each other; both lots are behind P.R. 2.
- C. 1, only one larva now living.

5th day:—P.R. 1, is still a long way behind P.R. 2.
- P.R. 2, mostly full grown, but none have pupated yet.
- C.W.L. 1 and 2, mostly full grown, but no pupæ yet.
- C. 1, all the larvæ are now dead.

6th day:—P.R. 1, no pupæ yet.
- P.R. 2, four have pupated.
- C.W.L. 1 and 2, no pupæ yet, but the larvæ are casting the chitinous tube which contains the food within the gut.

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*The eggs from which these larvæ hatched had been kept dry for three weeks; the larvæ emerged from them within one hour of immersion.

FINAL RESULT.

Lot.	Number of adults reared.	Time occupied from hatching to adult stage.			Mortality.	Remarks.
		Shortest.	Average.	Longest.		
P.R. 1 ...	5	10 days	12 days	15 days	50 per cent.	1 larva lived 34 days with abundance of food and then died.
P.R. 2 ...	4	8 ,,	9 ,,	11 ,,	60 ,, ,,	...
C.W.L. 1	9	9 ,,	11 ,,	14 ,,	10 ,, ,,	...
C.W.L. 2	6	9 ,,	10 ,,	11 ,,	40 ,, ,,	...

A comparison of these results with those obtained in Experiment No. XXVI. in respect of the larvæ fed on rice (P.R. 1 and 2), and those fed on leaves of the cottonwood tree (C.W.L. 1 and 2), brings out clearly the effect of scarcity of food on the one hand, and the possibility of water, overloaded with organic matter, being unhealthy if the larvæ are not numerous enough to cope with it, on the other.

In this experiment, as in No. XXVI., the advantage at the beginning between the pairs was again with the larvæ placed in the beakers where bacterial growth had the start; the final reverse of position between the pairs, though less marked, is still sufficiently in agreement to suggest that this is a real divergence and not a mere chance occurrence.

In the case of the pairs fed on cockroach (C. 1 and 2) the oily nature of the food material must be considered as chiefly, though not entirely, responsible for the ensuing mortality. For, even when the surface scum was broken up and a quantity of fresh water added, and these beakers produced some healthy adults, still the mortality was high.

Fifty larvæ which had emerged from their eggs an hour or two previously were added to beaker C 2, the covering of scum being broken up. They grew very slowly at first and there was a heavy death rate, but by the third day the survivors were making extraordinarily rapid progress and by the fourth day were in the fourth skin. All but one had pupated by the sixth day. Twenty-two adults were reared, eight within seven days; the average time being eight-and-a-half days, and the longest period between egg and adult eleven days.

A smear of the gut of a larva taken from this batch showed only two or three bacteria to a field, and one from a pupal gut was free so far as the microscopic test went; yet the water in which these larvæ were living swarmed with bacteria.

During the progress of Experiments Nos. XXVI. and XXVII. it became evident that the introduction of larvæ may have a remarkable clearing action on foul, cloudy water, if the conditions are properly balanced in respect of the number of larvæ and the quantity of water.

A test was made of the water from beaker C. 1. after the death of the last larva on the third day (the eighth day of the growth of the bacteria), the water showed an enormous bacterial infection, only

comparable with a broth culture. This water was put into a glass dish and diluted with four times its own volume of tap water, which rendered it less dense, but left it still cloudy; two hundred first skin larvæ were then placed in the dish, they grew with great rapidity, and as they progressed the water cleared, finally entirely losing all trace of its cloudy appearance.

The water in beaker C. 2 retained its thick, cloudy appearance *after* the development of the fifty larvæ above alluded to. It was decided to use this water for a further test regarding the clearing action of the larvæ.

A microscopic examination by wet films and stained smear (carbol thionin blue) showed the water to be swarming with bacteria—three forms predominating. One of these was a large and a very distinctive serpentine form. About one hundred first skin larvæ were added to the 200 cc. of foul water; they made very rapid progress. Two days later most of them were half grown, while the water had become quite clear. Microscopic examination showed a very marked reduction in the number of bacteria, with an entire absence of the large serpentine form.

Addendum.

Two beakers, in every respect similar to those used in the above experiment for P.R. 1 and C.W.L. 1, were prepared and stocked with the same number of larvæ.

Larvæ and pupæ were taken from these beakers at intervals and dissected, smears of the gut and its contents being fixed and stained in the same manner as sample drops of water. While the water in these beakers showed an identical infection with that in P.R. 1 and C.W.L. 1, in above experiment, the smears of the larval guts showed few, if any, bacteria to a field, and the pupal none at all.

Experiment No. XXVIII.

POSSIBLE RELATIONSHIP BETWEEN THE DEVELOPMENT OF BACTERIA AND THE GROWTH OF THE LARVÆ.

This experiment was a further attempt to solve the question of a possible relationship between the development of bacteria or other small organisms and the larvæ. The quantities of the different foods used were varied in the light of past experience in previous experiments.

On the 20th May, into four beakers, carefully cleaned and covered with thin cotton as in the previous experiments, were placed the following:—

Into G. 1 and G. 2 0·15 gr. of desiccated fragments of grasshoppers was placed.

Into C.W.L. 1 and C.W.L. 2, 0·5 gr. of desiccated fragments of fallen cottonwood leaves.

200 cc. of tap water was then added to G. 1 and C.W.L. 1.

On the 24th May, four days later, an examination of the water in G. 1 showed that it was thick and cloudy, while bacteria were present in immense numbers, three or four forms being especially noticeable:—

(1) A small, very short rod-shaped bacillus in dense clusters.
(2) Two forms (possibly of the same species) of large rods generally distiibuted but occasionally forming chains.
(3) Large serpentine forms scattered throughout the mass.
No paramæcium or rotifers seen.

C.W.L. 1, water clear but with fluffy patches. Bacteria less numerous, but still in great numbers. The large serpentine forms not present. A few paramæcium and a single specimen of a rotifer seen.

200 cc. of tap water was then added to G. 2 and C.W.L. 2.

16 newly hatched larvæ were placed in C.W.L. 1 and 15 in C.W.L. 2.
25 ,, ,, ,, ,, ,, ,, G. 1 and G. 2.

1st day (24 hours from start):—
G. 1, a number have moulted.
G. 2, none have moulted.
C.W.L. 1 and 2, none have moulted.

2nd day:—G. 1, nearly all in third skin and mostly well grown in it; one seen in first and one in second skin.

G. 2, a few (possibly one-third) in third skin, but the larger number in the second and two or three seen in the first skin.

C.W.L. There is not much to choose between C.W.L. 1 and C.W.L. 2; C.W.L. 1 has a few "stars" whereas C.W.L. 2 are more even in growth. Only one-fourth to one-third are in the third skin and these have only just attained it; on the other hand, there are no second skin "laggards."

3rd day:—G. 1, 1 still in second and 1 in third skin; the remainder are in their fourth skin, mostly full grown, but none have yet cleared the gut in preparation for the pupal stage. The water is now less cloudy than in G. 2.

G. 2, are very noticeably behind and have a higher death-rate. While most of them are in their fourth skin, and a few are as forward as G. 1, there are several that have only recently attained the third skin, and at least two are still in the second. Water very cloudy.

C.W.L. 1, about half are in their fourth skin and fairly grown, but slender (fat body ill developed); remainder in third skin. Water clear, brighter, and more deeply coloured than C.W.L. 2.

C.W.L. 2, are possibly a shade more backward than C.W.L. 1, but the difference is very slight.

Examination of Water.

4th day:—G. 1, after eight days, larvæ having been present for half the period, the water is nearly clear. Bacteria, though still plentiful, are in greatly reduced numbers. The serpentine forms and large rods are scarce, and there is also a marked absence of the dense clusters of the smaller bacilli.

G. 2, after four days, during which larvæ have been present all the time, the water is thick and cloudy, and there has been a considerable mortality. Bacteria are present in great numbers, but the large rod and serpentine forms are less numerous than they were in G. 1 before the larvæ were added. The most noticeable difference now is the absence in G. 1 of the dense clumps of short rod forms and their presence in G. 2.

C.W.L., the water in C.W.L. 1 is slightly darker than in C.W.L. 2, but both are clear and bright. There is, if very careful comparison is made, a trace of dulness in C.W.L. 1.

C.W.L. 1, shows very few bacteria, but much fluff, possibly cellulose fibre.

C.W.L., 2, shows a heavy infection compared with C.W.L. 1, mostly small forms with a few of the large chain-forming rods. No clusters and no serpentine forms.

Development of Larvæ.

G. 1, 1 pupa, 1 in second skin, 1 in third skin; remainder full fed (fat bodies developed), 22 living.

G. 2, no pupæ; no "laggards" (probably dead), only 13 living, all of which are full-grown.

C.W.L. 1, all in fourth skin, mostly full fed, 16 living.

C.W.L. 2, all in fourth skin, mostly full fed, 14 living.

5th day:—G. 1, 17 pupæ, 3 full fed larvæ, 1 just into third skin.

G. 2, 9 pupæ, 4 full fed larvæ.

C.W.L. 1, 4 pupæ, 10 larvæ, full fed.

C.W.L. 2, 4 pupæ, 14 larvæ, full fed.

Final Result.

Lot.	Number of adults reared.	Time occupied from hatching to adult stage.			Mortality.
		Shortest.	Average.	Longest.	
G. 1 ...	15 males, 7 females	6 days (10 males, 2 females)	6·5 days	8 days (2 females)	12 per cent.
G. 2 ...	11 males, 2 females	6 days (2 males)	7·1 „	8 days (3 females)	48 „
C.W.L. 1	10 males, 6 females	7 days (6 males, 1 female)	9·6 „	18 days (2 females)	Nil.
C.W.L. 2	5 males 9 females	8 days (1 male, 3 females)	14·8 „	24 days (1 female)	7 per cent.

After the emergence of the adults in beakers G. 1 and G. 2, on the 8th day after the introduction of the newly hatched larvæ, an examination of the water was made.

G. 1 appeared nearly clear; quite clear in comparison with G. 2. The bacteria present, though numerous, were relatively few in comparison with the conditions at the beginning of the experiment. Only occasional serpentine forms and single individuals of the large chain-forming rods were to be met with; very few clusters of the small short rods and such clusters when seen were small.

G. 2 was still swarming with large clusters of the short rods, while chains of the large rods and serpentine forms were numerous; the water being very thick and cloudy.

Sequel.

A fresh batch of 20 newly hatched larvæ were added to each beaker.

1st day (24 hours later):—G. 1, nearly all in second skin.
G. 2, all are in their second skin.

2nd day:—G. 1, mostly just into third skin, two or three in second and one or two in first.
G. 2, are all in third skin and mostly well grown in it; they are well ahead of G. 1 and the water is now nearly clear.

3rd day:—G. 1, mostly in third skin; two still in second and one in fourth skin.
G. 2, One in third, remainder in fourth skin—nearly all full fed.

4th day:—G. 1 and 2, compared, the water in G. 2 is yellower, but both are equally clear; as regards the development of the larvæ there is no comparison.
G. 1, are marking time in the third skin; only one has reached the fourth, and two remain very small in second or third skin.
G. 2, on the other hand, are all in the fourth skin; most of them with well developed fat bodies.

5th day:—G. 1, still marking time.
G. 2, 8 pupæ; remainder full grown.

Final Result of Sequel.

Lot.	Number of adults reared.	Time occupied from hatching to adult stage			Mortality.
		Shortest.	Average.	Longest.	
G. 1 ...	1 female	32 days	...	...	95 per cent. 1 larva lived until the 59th day and then died.
G. 2 ...	7 males, 9 females	6 days (2 males)	8 days	12 days (1 female)	20 per cent.

In view of the comments on Experiment No. XXVII. these last results scarcely call for any remarks; the experiment satisfactorily disposes of any remaining doubts as to the interaction of bacterial development and larval growth. The tentative suggestions put forward in the comments on Experiment No. IV., to the effect that bacteria took nutriment from the water which, even in the event of the larvæ devouring them, could not be regained, is confirmed by the results following the re-stocking of beakers G. 1 and 2 after the first broods had been reared. The success attending the careful adjustment of food to the quantity of water and number of larvæ also testifies to the correctness of the conclusions concerning these points in the comments at the close of the various experiments.

There seems little doubt but that the bacteria* themselves form a readily assimilable form of food for the larvæ, although, from the point of rigid economy, a certain wastage occurs unless the several factors are very nicely adjusted. This, however, in the terms of the case is likely to happen under natural conditions.

Experiment No. XXIX.

ABILITY OF THE LARVÆ AND PUPÆ OF *STEGOMYIA FASCIATA* TO SURVIVE COMPLETE SUBMERGENCE.

183 larvæ and 40 pupæ were placed in a wire gauze tube, 5 inches by 2 inches. The tube was then submerged in a large pan of water, the top of the tube being 2 inches beneath the surface. Some of the larvæ escaped through the 18 x 18 mesh of which the tube was constructed, and pupæ were also found outside, but these individuals may have escaped while yet larvæ.

After 20 hours an examination showed that 36 per cent. had escaped through the mesh. Of those which remained, 78 per cent. had been killed.

Pupæ— 3 living, 36 dead; mortality, 92 per cent.
Larvæ—28 „ 76 „ „ 73 „ „

No attempt was made to resuscitate the apparently dead.

Experiment No. XXX.

TEMPERATURE EFFECTS ON LARVÆ AND PUPÆ OF *STEGOMYIA FASCIATA*.

Heat.—Experiments were conducted in a tin pan about 6 inches in depth, holding 6,000 cc. of water with a surface area of 80 square inches, placed in the open on bare earth and exposed to the full heat of the midday sun during the latter half of November. These showed that both larvæ and pupæ could easily withstand such conditions, no mortality at all being observed. The test was commenced when the larvæ, from eggs laid in the pan by wild females, were half grown (after the second moult).

* Experiments which are now being performed in collaboration with Dr. E. E. Atkin prove that washed bacteria alone afford favourable food for the larvæ, and further suggest, though this is not yet definitely established, that the presence of living bacteria are essential to the development of the larvæ.

The temperature of the water taken on three successive days was as follows, care being taken that the thermometer was placed in the shade of the side of the tin :—

24th November,	3 p.m.	...	...	101° F.
25th ,,	3 ,,	...	...	103° ,,
26th ,,	9 a.m.	...	...	75° ,,
26th ,,	3 p.m.	...	...	101° ,,

Larvæ and pupæ were taken from this pan with a quantity of the water and put into a beaker; this was placed in a water bath and the temperature slowly raised. After 10 minutes the temperature reached 110° F., the pupæ remaining active, but they all kept close to the surface. Between 112° and 115° F., reached within 15 minutes, both larvæ and pupæ died.

Larvæ from the pan were treated similarly, but the course of the experiment was interrupted; the moment the thermometer registered 112° F. the beaker was removed from the bath and allowed to cool. All the larvæ seemed to be in difficulties; most of them remained at the surface, but a few continued to show slight activity at the bottom. 20 hours later, the water having fallen to the laboratory temperature of 80° F., about one-third to one-half of the larvæ had recovered their activity or had pupated, the remainder were either dead or dying. The survivors nourished upon the dead bodies of their comrades successfully completed their development, producing adults which, so far as outward appearance was concerned, were normal.

From this it would appear that the upward limit of temperature is in close agreement with that for other insects, as shown by Blacklock (1912) with bugs and Bacot (1914) with bugs, fleas and cockroaches.*

Cold.—A number of larvæ and pupæ were taken from various breeding pans in which the water temperature was in the neighbourhood of 80° F.

The beaker to which they had been transferred was placed in the ice chest and cooled to about 74° F.; this change did not affect the insects at all. It was then placed on a block of ice; after one hour the temperature of the water had fallen to 49°–50° F. All the pupæ remained active, and one adult (a female) had emerged; about half the larvæ, including both small and large, had fallen to the bottom stiff and immovable, to all appearance dead. After a further two hours on the ice the temperature had fallen to 40° F., and all the larvæ were in stiff and stretched out positions at the bottom; while all the pupæ, with one or two exceptions, were immobile and lax at the surface. The beaker was removed from the ice and the temperature allowed to gradually rise. At 60° F. all the pupæ had regained their full activity, but the larvæ showed no signs of recovery until the temperature rose to 70° F. An hour later, when the temperature had reached 80° F., nearly all the larvæ had recovered their activity.

Next day.—6 larvæ and 2 pupæ were dead out of 40 larvæ and 24 pupæ submitted to the test; 6 adults had emerged from pupæ; from the remaining larvæ and pupæ 47 adults were reared.

The female which emerged from the pupæ while the beaker was on ice was placed in a box and put on the ice beneath the blanket. After two hours she showed no effect from the cold beyond being slightly sluggish. After twenty-four hours she was still living and active. The melting of the ice prevented a continuance of the test.

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* Adults of *S. fasciata* are quickly killed at a temperature of 50° C.

Experiment No. XXXI.

SURVIVAL OF LARVÆ OF *STEGOMYIA FASCIATA* ON WET FILTER PAPER.

A larva in its fourth skin was stranded on a piece of filter paper ; after one hour's drying the paper had become stiff and dry. The larva was shrunken in appearance and incapable of movement. The small piece of paper on which it lay was snipped off and returned to the water. The larva lived and remained active for 44 hours, during which period it could not get to the surface for air, owing to one of its gills being stuck to the paper.

Two pupæ and two larvæ were found stranded on wet mud at the bottom of a half cocoanut shell. They were removed to wet filter paper and placed in a moist cell. Within twenty-four hours both the pupæ had developed and adults emerged, but failed to finally free themselves from the pupal envelope. One larva died after three days, the other lived for ten days, during which period, although kept wet, it was unable to move.

Experiment No. XXXII.

ENEMIES IN THE LARVAL STAGE.

MacGregor, in his notes with reference to the *breeding of *Stegomyia fasciata* in London, states that the young larvæ are consumed by the larger ones. The high rate of mortality among newly hatched larvæ placed in breeding pans which were already stocked, or had been previously used for breeding, was noticed early in the course of the results at Freetown, but the cause was not determined. Cannibalism among larvæ of the same age, though watched for under starvation conditions, was never detected. What appeared to be a flagrant case proved, on close observation with the binocular dissecting microscope, to be two fully grown larvæ, one half-grown and a very small one, with their jaws hopelessly entangled in a small mass of silk or hairs, probably a fragment of some insect cocoon. To the unaided eye the presence of the smallest larva was not apparent, and appearances suggested that two full-sized larvæ were attacking a smaller one. After watching half-an-hour's vain struggles, a few moments' aid with dissecting needles set all four free.

Larvæ and pupæ which died in breeding jars and pans where food had been purposely cut down to a minimum were noted as being untouched until the process of decay set in, when they soon disappeared, and a spurt by one or more of the survivors suggested that the nutriment set free had been absorbed, even if the carcase had not been eaten piecemeal.

Experiments carried out in London after my return home confirm MacGregor's observation. Newly hatched larvæ when about to moult are apparently devoured by those which have attained their fourth instar, but it

* "Journal of Tropical Medicine and Hygiene," Sept. 1st, 1915 ; No. 17, Vol. XVIII., pp. 193-6.

is questionable if danger results from the presence of third instar larvæ. A single third instar larva was placed in a pan with 9 newly hatched ones; after three days, no food being present, 8 living and 1 dead larvæ were present in the pan, in addition to the third instar larva.

Result, negative.

6 newly hatched larvæ were placed in a glass pan with 5 larvæ in their fourth skin. After 24 hours all the young larvæ were present, some of them having moulted.

23 more newly hatched larvæ were added to the pan and 7 more fourth skin larvæ, so that the numbers stood at 12 fourth skin and 29 young larvæ, mostly newly hatched.

After 48 hours all the young larvæ were still living and one of the fourth skin larvæ had pupated.

After 72 hours the young larvæ were still living.

After 96 hours the young larvæ were still living, and were many of them in their fourth skin, while several of the fourth skin larvæ had pupated.

Result, negative.

A fresh trial was made with—

51 newly-hatched larvæ and 20 fourth skin larvæ, in various stages of growth. The pan was of the same size as in the previous experiment. After 20 hours only 35 of the newly-hatched larvæ could be found, 31 living and 4 dead—a mortality of 31 per cent. = a ratio of four-fifths to each fourth skin larva. Of the living larvæ 13 had attained the second skin.

Result, positive.

40 larvæ that had completed their first moult were then placed in the pan with 22 larvæ in their fourth skin.

After 48 hours all the second skin larvæ were still living, a number having moulted for the second time.

Result, negative.

12 newly hatched larvæ were placed with 5 in their fourth skin into a small glass dish.

After 48 hours there were only 10 of the small larvæ present and 1 of these was dead, a loss of 16 per cent. = a ratio of two-fifths to each fourth skin larva.

Result, positive.

Test in filtered Manure Water.

200 newly-hatched larvæ were placed with 20 fourth skin larvæ in various stages of growth.

After 24 hours only 176 of the young larvæ could be found, a loss of 12 per cent. = a ratio of $1\frac{1}{5}$ newly-hatched to each fourth skin larva.

Result, positive.

88 newly-hatched larvæ were placed with 4 in their fourth skin.

After 24 hours only 82 of the young larvæ could be found, a loss of 7 per cent. = a ratio of $1\frac{1}{2}$ to each fourth skin larva.

Result, positive.

70 newly-hatched larvæ were placed with 10 in their fourth skin.
After 24 hours only 68 of the young larvæ could be found, a loss of 3 per cent. = a ratio or $\frac{1}{5}$ to each fourth skin larva.
Result, positive.

Test in clean Tap Water.

110 newly-hatched larvæ were placed with 16 in their fourth skin.
After 18 hours only 106 of the young larvæ could be found, a loss of 4 per cent. = a ratio of $\frac{1}{4}$ to each fourth skin larva.
Result, positive.

179 larvæ in their first skins, most of which had just emerged from the egg, were placed with 20 in their fourth skins.
After 24 hours all the young larvæ were present but 3 were dead.
Result, negative.

332 newly-hatched larvæ were placed with 14 in their fourth skins.
After 18 hours only 316 of the young larvæ could be found, a loss of 5 per cent. = a ratio of $1\frac{1}{7}$ to each fourth skin larva.
Result, positive.

A number of dissections were made of the fourth skin larvæ used in the above tests and also of fourth skin larvæ in various stages of growth which had been kept for from two or three hours up to a day or longer in jars of water with large numbers of newly-hatched ones. No remains of small larvæ, however, were traced in either stomach or intestine. Close observation on several occasions revealed no cases of ingestion and no desire or attempt was ever evinced by large larvæ to catch the small ones. Even under such crowded conditions that accidental ingestion seemed inevitable the act was never witnessed. The sole direct evidence of ingestion obtained was the head capsule of a first skin larva recovered from fæces passed by a fourth skin larva. The conditions under which this was found, however, preclude it being a case of the swallowing of a cast skin unless it had remained in the gut for two or more days, as none of the young larvæ had moulted during the period of the experiment.

On the whole the evidence (especially the frequent finding of *dead* first-skin larvæ in containers in which fourth skin larvæ are present) seems to point to the devouring of the young larvæ by the larger ones being a matter of chance. There remains, however, the possibility that cannibalism is a variable habit occurring in a few larvæ or certain strains of the insect only.

It seems therefore that the fourth instar larvæ may be themselves among the most formidable agents in the destruction of their species. The habit of breeding in small collections of water, while saving the species from a death toll by other enemies, enhances the opportunities and danger of fratricide. The action of the two habits, together with the intermittent hatching of the eggs, will be that of a sliding scale to keep the adult population at a comparatively even level. It will be a matter of some interest to see if the same habit of fratricide obtains in other species.

Apart from either competition or fratricide, breeding in small scattered collections of water largely precludes the action of predatory enemies during the larval stage of this species. Ducks, if free to roam about the precincts of the dwelling, will doubtless do an enormous amount of useful work; they will, however, destroy other predatory enemies of mosquitoes,

such as frogs, dragon fly larvæ and water beetles, which may be present in the larger pools, without discrimination. This does not seriously militate against their services, however, as most of the larger predatory insects, at any rate, are likely to have a wider range than mosquitoes, and will tend to rapidly repopulate from outside the areas cleared by ducks.

Fish, which are of great value in holding in check species of mosquitoes which breed in permanent pools or streams of water, are likely to be of small value as enemies of *S. fasciata*, although species with similar habits to those of carp and tench might be utilised in water butts or cisterns.

Tadpoles, as stated by Stephens and Christophers (1908) and other authors, do not attack mosquito larvæ, though they probably have a checking influence owing to competition in the matter of food supply. Direct experiment proved that even in a crowded jar there was no mortality to well grown mosquito larvæ, transformation to the adult stage taking place as usual. It is possible, however, that the small larvæ undergoing the first moult might be engulfed.

A small water-bug belonging to the *Micronecta* was found in very small rock pools with larvæ of *S. sugens* and *Anopheles costalis*. In captivity it attacked and sucked the juices of larvæ of *S. sugens*. Its power of flight would enable it to transfer itself from pool to pool if scarcity of food or drought rendered them untenable, but the species was never seen in sufficient numbers to warrant the supposition that it would do more than take a moderate toll of the larvæ it fed on.

The presence of a species of *Ostracoda*, probably belonging to the genus *Cypris*, in breeding pans or jars appears to be inimical to mosquito larvæ. This seems to be due to competition in respect of food solely, as the larvæ (*S. fasciata*) added to water containing the *Ostracoda* live for a longer or shorter time, but seem unable to proceed with their development, few, if any, succeeding in attaining the adult stage. A similar phenomenon has been noted in England with regard to *Culex pipiens*—small pools in Epping Forest which were populated with a minute crustacean being free of mosquito larvæ.

(*C*) ADULTS.

General Notes.

Pairing and feeding with *Stegomyia fasciata in captivity* are not restricted to any particular period of the day or night. No doubt if an accurate census could be taken, the late afternoon or evening might be found to be the most favoured period, but when numbers of recently emerged specimens are placed in a cage pairing commences almost immediately, and feeding, on the part of a proportion of the females, at the earliest opportunity.

There seems to be no regular precedence of one or the other function, but females heavy with blood are too sluggish to pair and tend to rest low down in the cage, or even on its floor. Anything less than a full meal only slightly impairs their activity and pairing proceeds as usual. If the initial meal of blood be interrupted they will feed again within the next few minutes, satiety being evidently instinctively aimed at.

Feeding.—The effect of drought as a deterrent to feeding was very noticeable, both in the cages within doors and especially in the mosquito house out of doors.

In the cages, both by day and at night, the harmattan periods did not interfere with feeding and egg laying to any extent, because the time allowed for feeding was ample, but in the mosquito house, where the visits were of short duration, the effect of dry periods was much more noticeable. In place of the surging swarms which usually rushed on their prey, only a few individuals put in an appearance to feed on my entrance. Within a few minutes, however, the insects issued from their hiding places and commenced to attack. The evidence as a whole suggests that, while the dry air is the cause of retirement to any available shelter from the wind, it is not disinclination to feed that prevents the mosquitoes biting so readily, but failure to recognize the presence of a host. Probably it is the absence of odour which delays attacks in dry weather. The bites, if numerous, have the effect of inducing a profusion of perspiration, especially in warm weather and before one becomes thoroughly inured to their attacks, while the free flow of perspiration seems to attract the insects.

Pairing commences during flight, but is usually consummated while at rest, and occupies but a few moments at most. The position when the pair have settled varies considerably. A tail to tail position was observed, but is rare ; side by side, with bodies tilted at an angle to each other and the surface on which they are resting is not uncommon, but the usual position seems to be for the male to embrace the female and underlie her with his back to the resting surface.

General observation suggests that the same female, possibly the same pair, copulate several times in quick succession, but no experimental proof of this was obtained when a single pair were segregated.

Captive females refuse to suck blood for some hours, in most instances for at least a day, prior to egg laying, and, if the bulk of their egg masses are not extruded on the first night, they will not as a rule feed again until after the deposition of the remaining eggs. Evidence is afforded by the record of the female used in Experiment No. IX. on page 34.

Vigorous females almost invariably feed within twenty-four hours after clearing their ovaries of mature eggs, and on the following day as well. On the third or fourth day they usually abstain, a fresh batch of eggs having developed. Weak or elderly females are much more erratic, both as to feeding and the deposition of eggs. There is direct evidence in Experiments Nos. XLI. and XLII. of the retention of eggs for considerable periods by some females. The proportion exhibiting the habit is not large, and the period of retention is variable ; while it is possible that further meals of blood would have induced some of these females to deposit their eggs earlier, it is to be noted that the habit was observed in a few instances in the case of females which were afforded nightly opportunities of sucking blood. Probably the habit affords evidence of a more or less latent instinct, connected with æstivation, which preceded the evolution by the various species of *Stegomyia* of eggs so perfectly adapted to resist drought as those which are now produced.

A single full meal of human blood was found to be sufficient for the development of the ovaries. Eggs were deposited in many instances after a single meal of blood, and trial showed that these eggs were fertile.

Females fed on a goat, dogs, a ground pig (Bandicoot) and wild rats *(Mus rattus)* also developed their ovaries after a single meal of blood from these animals. In the case of those fed on *Mus rattus*

trials were carried out to see if the eggs were ripe for deposition. A female was placed in a jar with wet filter paper and, after the lapse of a few days, deposited a batch of eggs which, after incubation, hatched within a few minutes of their immersion.

The laying of eggs on any diet other than circulating blood is a rare but not unrecorded phenomenon. Otto and Neumann (1905) succeeded in obtaining fertile eggs when the females had been fed on blood and salt solution. Two instances occurred in the course of the present research of single eggs being laid by females that had no opportunity of feeding on a living animal. In one case the females were fed on blood mixed with honey, in the other on blood mixed with syrup. In the latter instance the egg proved to be fertile. These foods were chosen with the special object of testing the practicability of breeding without allowing them to feed on a living animal, as the practical advantage of such a method would be very great. In the face of the extreme rarity of egg-laying under the conditions, however, the experiments must be considered as failing of their purpose.

Eggs were only deposited when water or saturated surfaces were available. An experimental test (No. XLIII.) carried out with a view to confirm this general observation resulted in a single infertile egg being laid by one of thirty-nine regularly fed and presumably fertilized females.

Length of Adult Life.

It is impossible to ascertain the length of life of adult mosquitoes under natural conditions. Even under semi-natural conditions the difficulties are great and increase just in proportion as nature is simulated.

The larger the containing cage, the greater the difficulties of counting and obtaining any exact figures of the mortality, while reduction in size leads to difficulties in feeding and the introduction of specimens.

In either case a small mesh netting (18 × 18 to the inch for *S. fasciata*) must be used to obviate escape; this greatly militates against a free draught of air, and in the case of small confining chambers it becomes only practicable to record the temperature and humidity in the immediate vicinity exterior to such cages.

Probably, while the shielding afforded by captivity tends to reduce the general mortality, no artificial conditions can be arranged so favourable to the exceptionally long-lived and lucky mosquito as those obtaining in freedom.

The ability to shift its resting place to meet the needs of every change of humidity or temperature both daily or hourly is an asset which is reduced to such narrow limits by captivity as to be all but valueless.

Two plans were followed to obtain feasible results in this research ; the one of confining 50 or 100 adults in wire gauze cylinders $4\frac{1}{2}$ ins. × 2 ins., the other of keeping them in the convenient cage that can be made out of a large sized hurricane lamp chimney, the top covered with fine gauze while the open lower end is placed downwards on a pad of either dry or wet filter paper placed in a wide shallow tin lid.

The first method allowed of the nearest approach to natural conditions of drought or humidity, it was possible to devise with the object in view, while the latter afforded a more favourable way of testing the effect of different foods, egg-laying, etc. The wire gauze tubes were placed in a variety of situations but the necessity of making use of some device to prevent the ants reaching them considerably limited the possible range.

Mosquitoes were allowed to emerge direct into the tubes, a plan that avoided much waste of time and allowed of accuracy in respect of their age, but had the disadvantage that records of sex and numbers could only be accurately ascertained after their death. The sex has been recorded wherever possible, but when the insects were placed in damp situations the remains were frequently too mildewed or decayed to admit of their sex being discriminated ; while in some instances the actual numbers after the mid period of the experiment are approximate only, owing to the same causes. Such situations as the Well in the Sanitary Department Compound, the Pit in the Mosquito house, and, in some cases, the Yard at 26, Westmoreland Street, led to trouble in this respect.

Ants were responsible for the wrecking of a number of experiments and caused both waste of time and effort, while the rotting through of the cord or rope used to lower the tubes and isolation pan down the well was a source of annoyance.

In all the experimental records the period of life tends to err by the length of the period between each examination. In every case the extreme has been taken, the mosquitoes being assumed to have lived up to the date on which they were found to be dead. In most cases the examination was daily, but in the Pit it was occasionally every other day, while in the Well only two examinations a week could be made, so that the error might amount to three or four days.

It will be safe, therefore, to assume that the lives recorded are the limits under the particular conditions involved.

Without food the adult life, under favourable conditions, although short, is by no means inconsiderable for so small and active an insect, an average of 6 to 8 days, with an extreme of 12 days, being recorded. This compares favourably with the records in which food was given in less suitable situations. It would appear to be a general rule that the environmental conditions are more important than the food; honey and syrup given under moist conditions giving a longer average life than blood under dry ones. Another point which the budget of record shows is that the kind of food given makes far less difference to the average length of life than it does to that of the exceptionally long lived individuals.

The second plan was used in the attempt to ascertain the extreme age limit under favourable conditions when fed on various foods.

Hurricane lamp chimney cages were also employed in the experiments dealing with egg production on a single meal of blood and the attempt to induce egg-laying by giving a mixture of blood, either fresh or dried, with honey or syrup as food. The air in these cages would be still, if not stagnant, so that the use of a dry, in place of a wet filter paper, as a base in some of the trials, would not necessarily cause a drying atmosphere, though of course it would be dry if compared with the saturated conditions which obtained when the base rested on wetted paper and the gauze top was covered with a piece of glass. All the experiments in which these lamp chimney cages were used were carried out at the quarters in Westmoreland Street, so that the working room temperature and humidity chart applies to all of them.

In the second series the advantages of moist over drier conditions are far less apparent, in fact, the suggestion is rather that humidity may be in excess of what is desirable from the mosquito's point of view. This impression is, however, partly due to an accident causing a high concentration of the syrup given as food in one of the experiments, and also to the fact that a number of the insects got their legs into a sticky condition, and this apparently raised the death rate at an early period of the experiment. On the whole, syrup gave a better result than honey, possibly because it was more fluid. Banana, again, gave less favourable results than either honey or syrup; this may also be owing to the fluids in the over-ripe fruit being less easily obtainable than syrup from cotton-wool. The longest female lives recorded in the series are of those

fed on a mixture of blood and syrup or blood and honey. The average ratio of life of the males in comparison with that of the females would seem to be from about 3 to 5 or 2 to 3.

An experiment (No. XLIII.) carried out with the double object of ascertaining if the females would lay eggs apart from water or wet surfaces, and their length of life when well fed on human blood under these conditions, shows that such circumstances are not detrimental to longevity, the average life of 31·3 days, with an extreme of 74 days, comparing not unfavourably with that recorded when they are afforded opportunities of oviposition.

Experiment No. XXXIII.

CHOICE OF SITUATION FOR OVIPOSITION BY FEMALES OF *STEGOMYIA FASCIATA.*

At an early stage of the research trials were commenced to see if ovipositing females lay their eggs in any receptacle containing water without reference to its situation or if, as is commonly stated, they show a preference for certain rooms or positions. Various utensils containing water were placed in the basement, outbuilding, yard, living room, bedroom, etc., in the quarters at 26, Westmoreland Street.

A careful search was made every three or four days for a month. The record is as follows:—

Bedroom.—1 larva, *S. fasciata.*

Bathroom.—A few larvæ and ova of *S. fasciata*, also a batch of eggs of *Culiciomyia nebulosa.*

Covered Wooden Gallery (containing pantry and sink where the "boys" wash up).—A few eggs and larvæ of *S. fasciata.*

These latter occurred in a water pan in which one of the legs of the safe was placed. It is possible that they resulted from eggs left over from the previous tenancy. The *basement*, *yard*, *kitchen*, *store-room*, *dining-room*, and *living-room* were all negative.

This preliminary trial was followed by another, covering the month of October, in which new card cream jars of one pint capacity were used, the jars being half full of filtered rain water. The situations were as follows:—

Bedroom.
Dining-room.
Sitting-room.
Store-room.
Hall.
Basement fronting on the street, kept closed but opening on the yard through an unglazed window.
Gallery with pantry and sink.
Kitchen.

Bathroom.
Room beneath bathroom where the house boy slept.
Cellar beneath kitchen.
Yard.

Careful search for eggs and larvæ was made every three or four days (twice a week).

RESULT.

Only the jar in the kitchen was visited. The water in this jar became very thick and foul owing to dust, dirt and insects falling in. Numbers of eggs of *S. fasciata* were laid in it. Although the jar in the gallery was not visited two of the water pans in which the legs of the safe stood had eggs laid in them, and a jar of water in the sitting-room in which some cut plants were placed also received the attention of an egg-laying female. The small jar placed in the yard was not visited, but a large tin bowl, put out with the object of getting a supply of rain water, was, and soon produced numbers of larvæ of *S. fasciata*, among which were some of *Eretmopodites quinquevittatus* and *S. luteocephala*.

In the mosquito house a wooden tub, several tin pans, and basins, and a new galvanized iron pail were used. Both the tins and wooden tub were favoured; the pail was avoided, and several successive lots of larvæ put in died off almost immediately.

It was not until after the pail had been twice thoroughly scrubbed out with soap and water, and allowed to stand in the sun for a week, full of rain water, that it became a possible breeding place for *S. fasciata*. Altogether, with the various tests in between the scourings, etc., it took a matter of six weeks to two months before the pail was serviceable for breeding purposes.

Experiment No. XXXIV.

BAITS TO ATTRACT PREGNANT FEMALES.

The perusal of minute Ref. C.O. 51,476, 24th December, 1914, together with the attached papers concerning a mosquito trap suggested by Dr. E. Peter, of Duala, Kameroons, led to further experiments designed to throw light on the extent to which ovipositing females select water contaminated with organic matter in preference to clean.

1st Trial.—A number of freshly emerged *S. fasciata* were put into a large cage. Honey was supplied for the males while the females were afforded ample opportunity of imbibing human blood every night.

Two beakers, each containing 200 cc. of tap water, had six slips of filter paper arranged with one end in the water and the other turned over the rim.

In one, *A*, nothing was added, in the other, *B*, two dead grasshoppers were placed. Both were placed in the cage containing the mosquitoes, and their relative positions were reversed during the course of the experiment.

After five days the water in *B* was cloudy and thick with a scum on the surface; it also smelt badly. The water in *A* was not appreciably less clear than at the start.

In *A*, 62 eggs (14 per cent. of the total) were laid on the filter paper at various distances between water level and one inch above it, mostly about midway up.

In *B*, 392 eggs (86 per cent. of the total) were laid, 28 on the surface scum, the remainder on the filter paper over a much wider area above water level than in *A*.

2nd Trial.—Into the same cage three beakers prepared as previously were placed.

Into *A*, tap water only.
Into *B*, 1 cc. of sheep's bile that had been kept for three months.
Into *C*, ·5 gr. of Bile Salts (Sodium Taurochlorate).

After two days in the cage eggs had been deposited as follows:—

A.	58 eggs on the filter paper 7 eggs on the glass or water surface	65 eggs = 23 per cent. of the total laid.
B.	71 eggs on the filter paper 29 eggs on the glass or water surface	100 eggs = 35 per cent. of the total laid.
C.	99 eggs on the filter paper 20 eggs on the glass or water surface	119 eggs = 42 per cent. of the total laid.

3rd Trial.—Four beakers were prepared as previously.

Into *A*, tap water only.
Into *B*, ·5 gr. of dried and powdered cockroach.
Into *C*, ·5 gr. of dried and powdered leaves of cottonwood tree.
Into *D*, ·5 gr. of dried crushed rice.

The beakers were then placed in an incubator at 95° F. for 24 hours and then put into the cage with the mosquitoes for two days, their positions being changed about after the first day.

After two days in the cage eggs had been deposited as follows:—

A.	418 eggs on the filter paper 15 eggs on the glass or water surface	433 eggs = 26 per cent. of the total laid.
B.	667 eggs on the filter paper 120 eggs on the glass or water surface	787 eggs = 48 per cent. of the total laid.
C.	160 eggs on the filter paper 28 eggs on the glass or water surface	188 eggs = 12 per cent. of the total laid.
D.	231 eggs on the filter paper 6 eggs on the glass or water surface	237 eggs = 14 per cent. of the total laid.

In all 1,645 eggs were laid.

The water in *B* had a whitish surface scum and smelt badly. In *C* it was pale brown and smelt rather like weak tea. In *D* it was thick and cloudy without any noticeable smell.

While the evidence of selection in all three trials appears definite, it is very far from being of the unanimous unvarying character that might be expected from a deep seated instinct coupled with larval needs. On the contrary, it carries with it a certain suggestion of bias on the part of the females in reference to their own tastes, largely parallel but not necessarily identical with provision for their offspring; otherwise, why the neglect of the suffusion of leaves, possibly bitter, and rice water, possibly sour, either of which would afford better chances for larval development than plain water?

Experiment No. XXXV.

LENGTH OF LIFE WHEN CONFINED IN WIRE GAUZE TUBES UNDER VARIOUS CONDITIONS.

In considering the relative length of life as recorded in the various trials, the situation as well as temperature and humidity must be borne in mind, as local conditions have a quite considerable influence on the amount of drought and circulation of the air.

Charts recording the temperature and humidity in the various places where the tests were made, follow the descriptions of these situations. In addition, a chart compiled from the official Meteorological Report of the 9 a.m. readings at the Freetown Meteorological Station is appended as a guide to the general conditions obtaining during the months that no records were taken in the various trial situations. The record for the well only covers the actual periods of the tests and is not translated into a curve.

A partial record of the maximum and minimum temperatures and weekly extremes is also appended. This covers the period from September 11th to December 4th in the laboratory, from December 4th to February 27th in the animal house, and from February 27th to July 31st in the mosquito house, and affords some idea of extremes registered in these three situations. As only one registering thermometer was available, it was a matter of choice between one complete or several partial records.

A record of temperature and humidity in the laboratory is included in the "General Notes" prefacing the larval section.

Yard at Quarters, Westmoreland Street.—This was small, overhung by trees, surrounded on three sides by buildings and on the fourth by a high wall. No weeds were present on the small plot of soil where the pen was fixed. On the whole a cool, moist, favourable situation. (*See* page 92).

Cage in Quarters, Westmoreland Street.—This stood on a table about 4 feet from the ground on the first floor facing the stairway. This situation was dark, a few gleams of late afternoon sunlight being the most that ever penetrated to the cage, but, on the other hand, it was well ventilated. (*See* page 93).

Compound at the Hospital.—The pen was placed in an open, sunny spot, slightly shaded at midday by eucalyptus trees. The insects confined here were subjected to greater extremes of heat and drought than in any of the other situations. (*See* page 94).

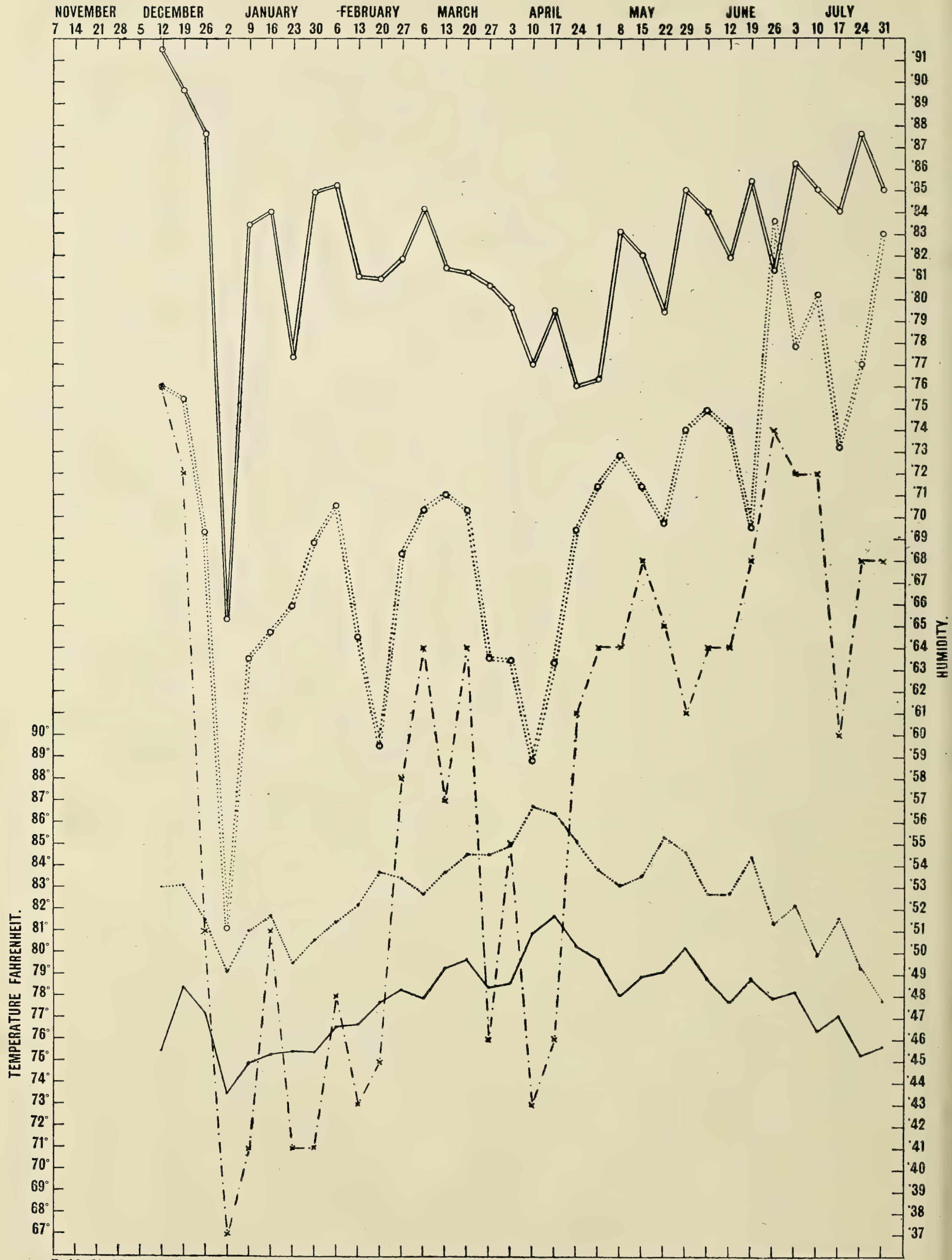
Animal House.—(Plate No. 20, page 96). Darker, cooler and less well ventilated than the cage at quarters in Westmoreland Street. The air would also be cooler and more moist at night. (*See* page 95).

Mosquito House.—(Plate No. 21, page 96). This was sheltered under a small but densely leaved tree and also by a tall shrub. It was shut in on east and south by buildings and on the west by a high wall a few yards distant from it. On the north it was exposed, but obtained some shelter from two small trees about ten yards away. On the whole, a shaded situation tending to be both cool and moist. (*See* page 97).

Mosquito House Pit.—The pit within the Mosquito House was two feet by two-and-a-half feet in area, and two feet deep, lined with rough planks. It was covered by a wooden lid, which left an open crack half an inch wide. This situation was very dark, ill-ventilated and humid. (*See* page 98).

Chart No. 2.

Curves of Temperature and Humidity in Yard at 26, Westmoreland Street, Freetown, Sierra Leone.



Observations made at 7 a.m. and noon each day:—

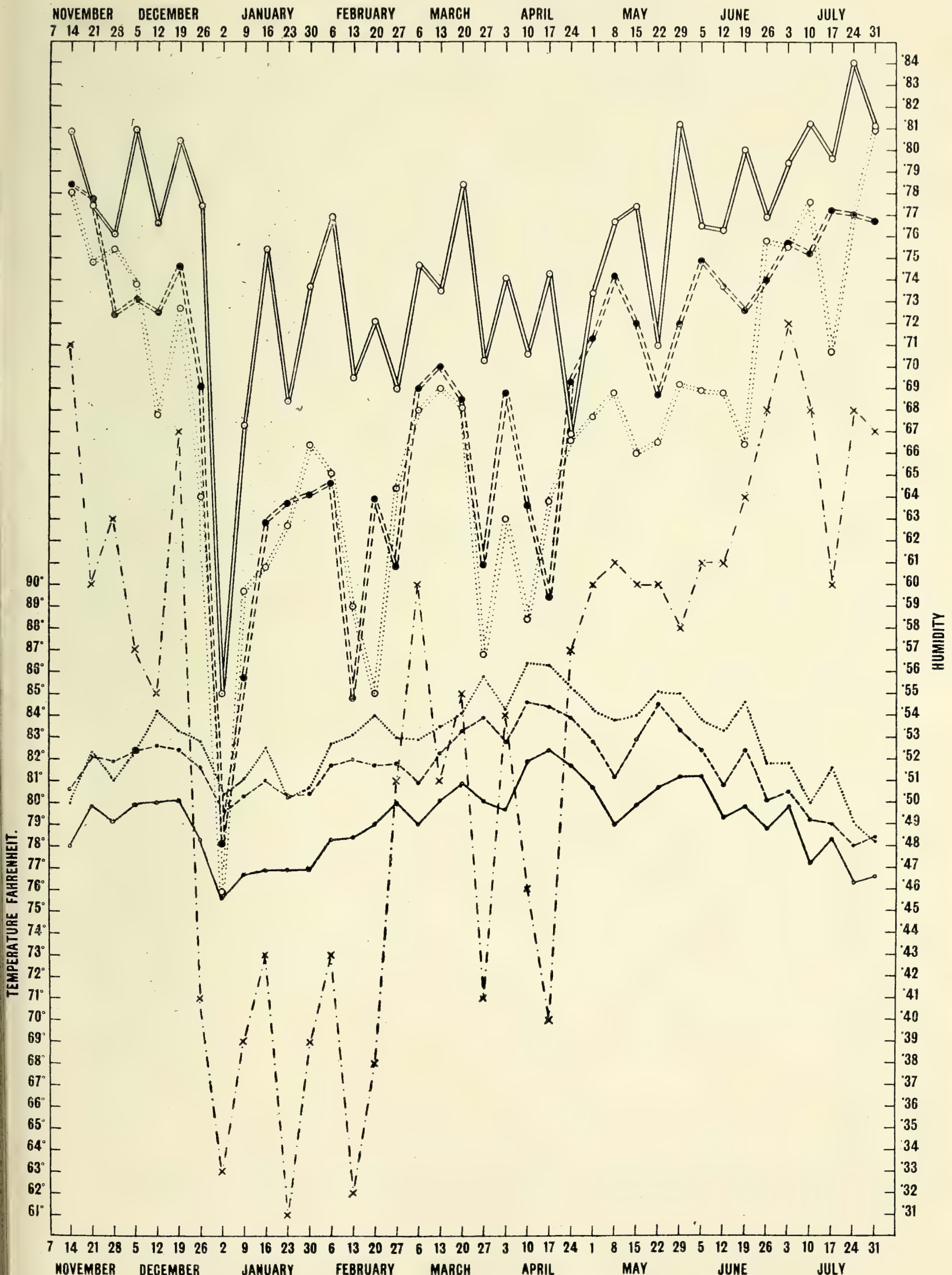
Temperature ———— 7 a.m. Humidity ════

„ . . . . Noon „ : : : : : : : : : : : :

Minimum Humidity records in each week — · — · — · — ·

Chart No. 3.

Curves of Temperature and Humidity in Working Room at 26, Westmoreland Street, Freetown.



Observations made at 7 a.m , Noon, and 7 p.m. each day :—

Temperature ———— 7 a.m. Humidity ════

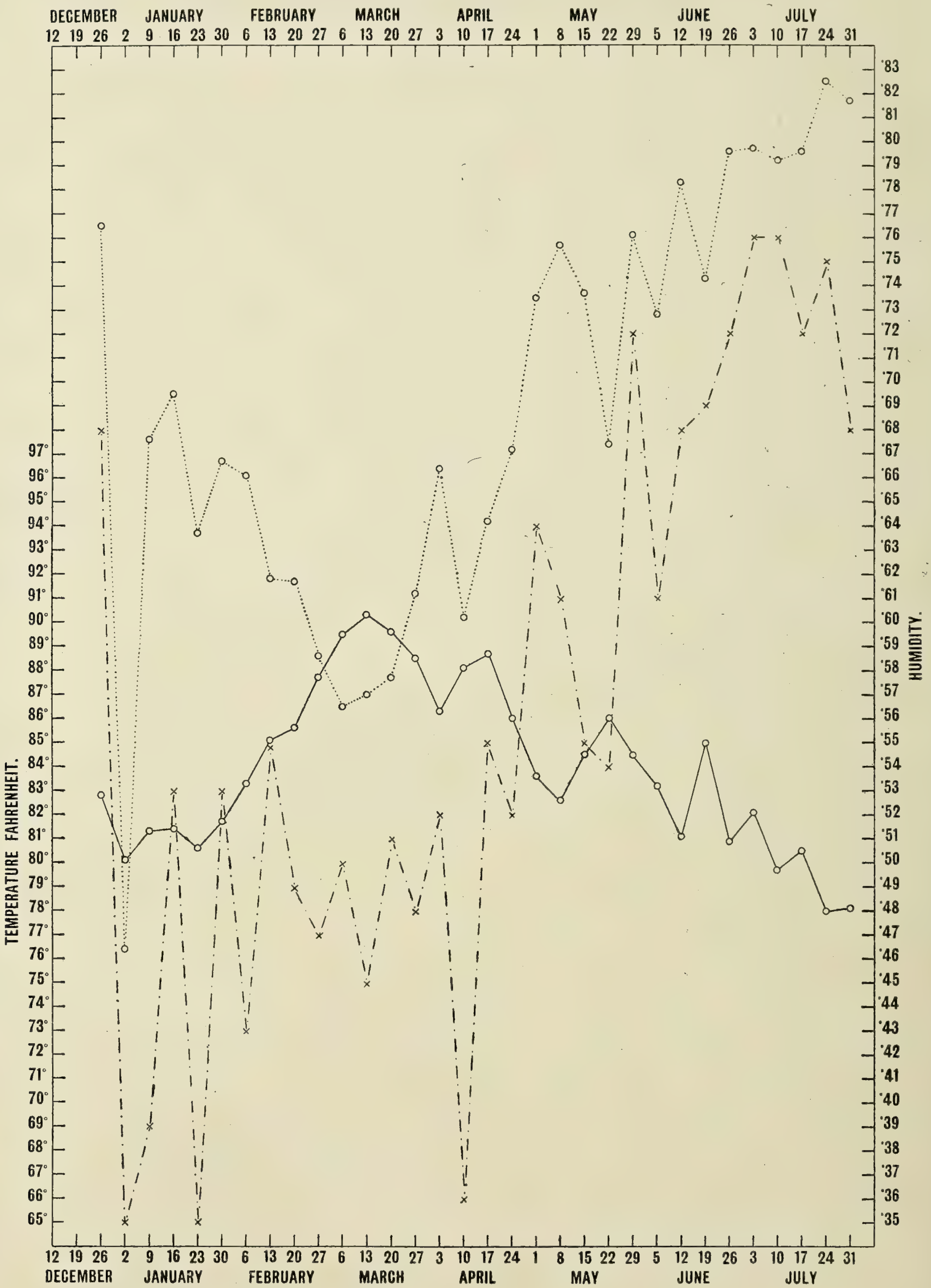
" . . . . Noon " : : : : : : : : : : :

" - - - - - - - - - - 7 p.m. " = = = = = = = = = =

Minimum Humidity records in each week — · — · — · —

Chart No. 4.

Curves of Temperature and Humidity in Compound at Colonial Hospital, Freetown.



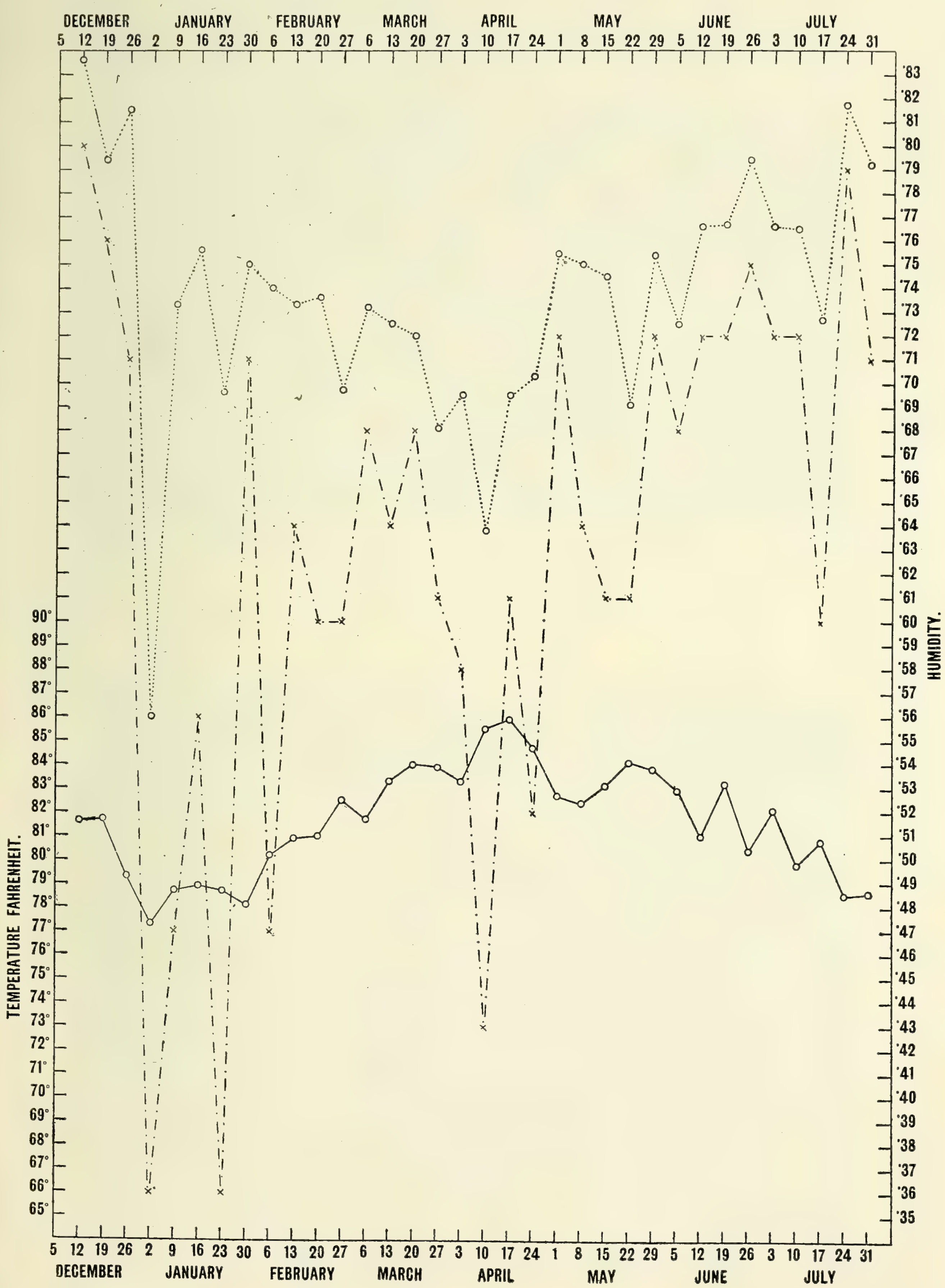
Observations at 9 a.m. each day :—

Temperature ———————— Humidity . . . .

Minimum Humidity record in each week — · — · — · — ·

CHART No. 5.

CURVES OF TEMPERATURE AND HUMIDITY IN ANIMAL HOUSE AT COLONIAL HOSPITAL, FREETOWN.



Observations at 9 a.m. each day :—

Temperature ———————— Humidity . . . .

Minimum Humidity record in each week — · — · — · — ·

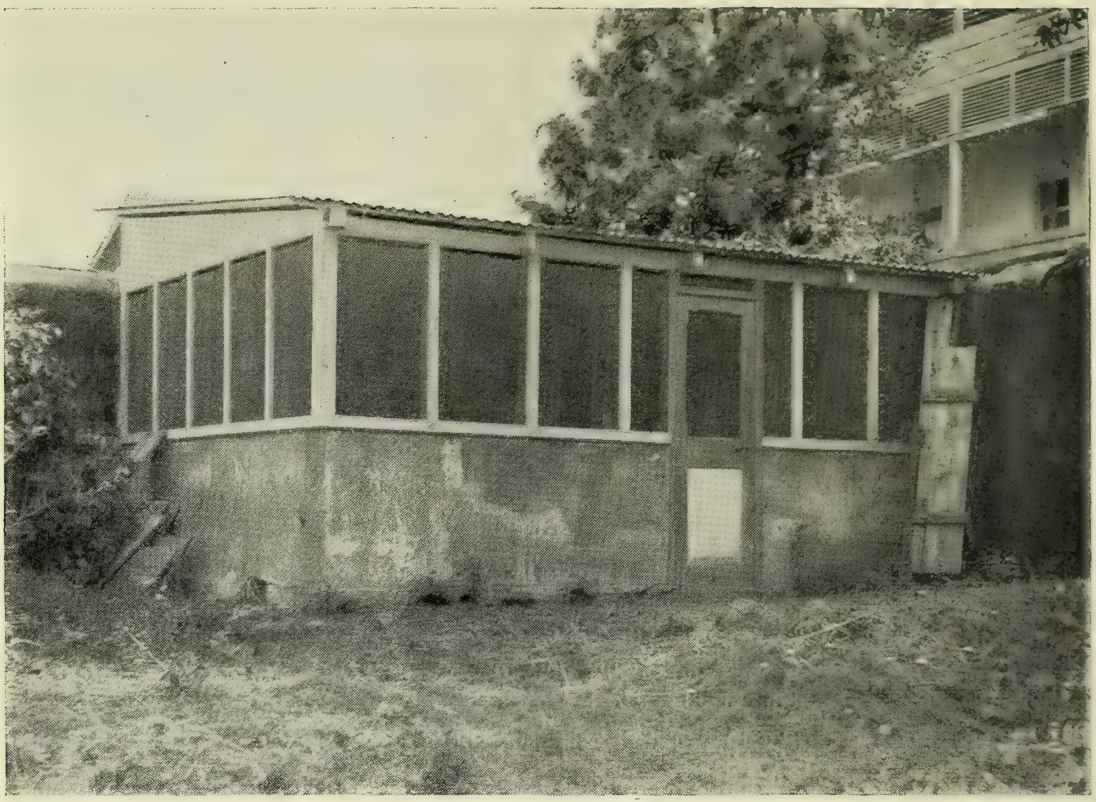


Plate No. 20.

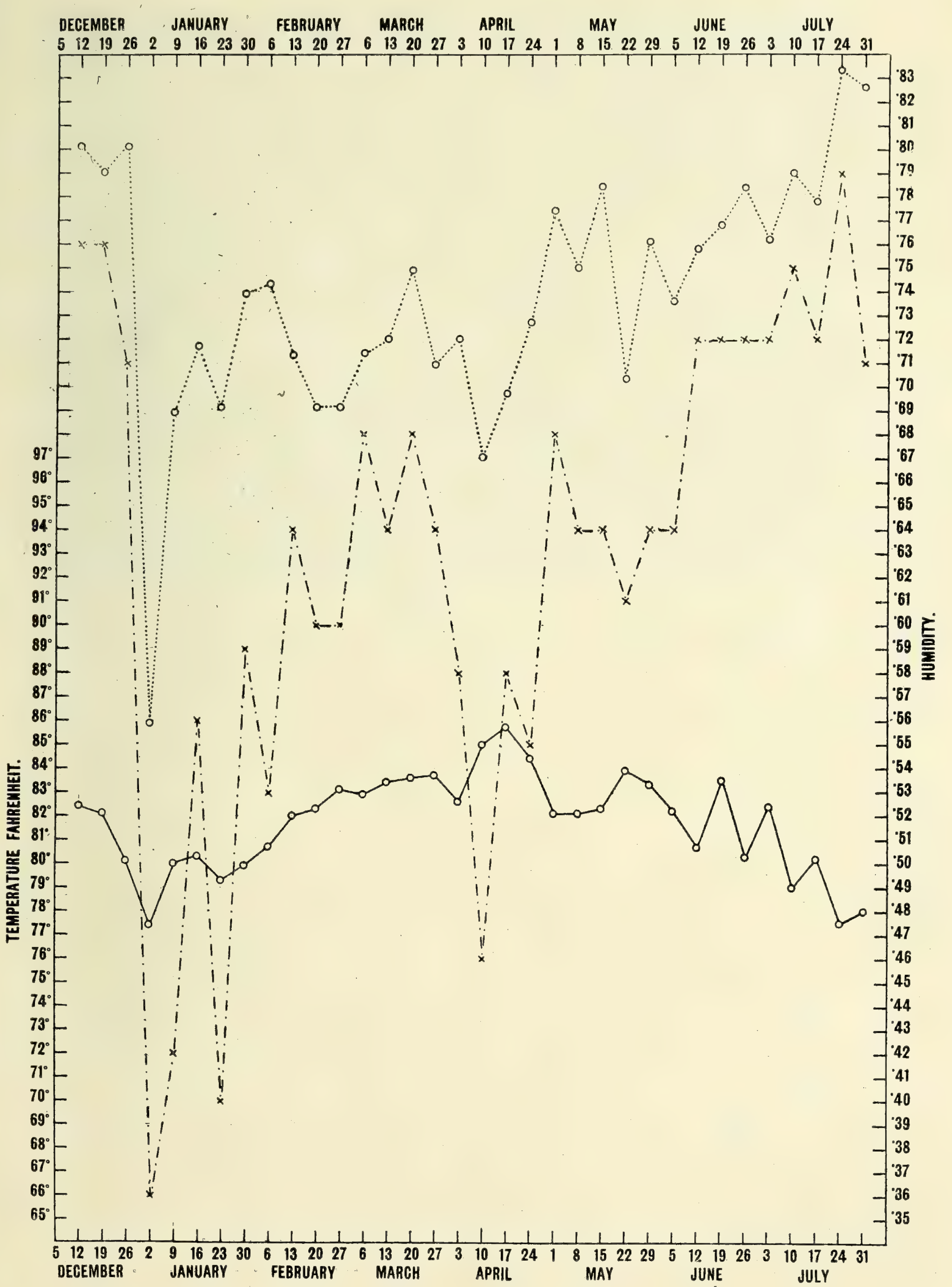
Animal House, Colonial Hospital, Freetown.

Plate No. 21.

The Mosquito House.

Chart No. 6.

Curves of Temperature and Humidity in Mosquito House at Colonial Hospital, Freetown.

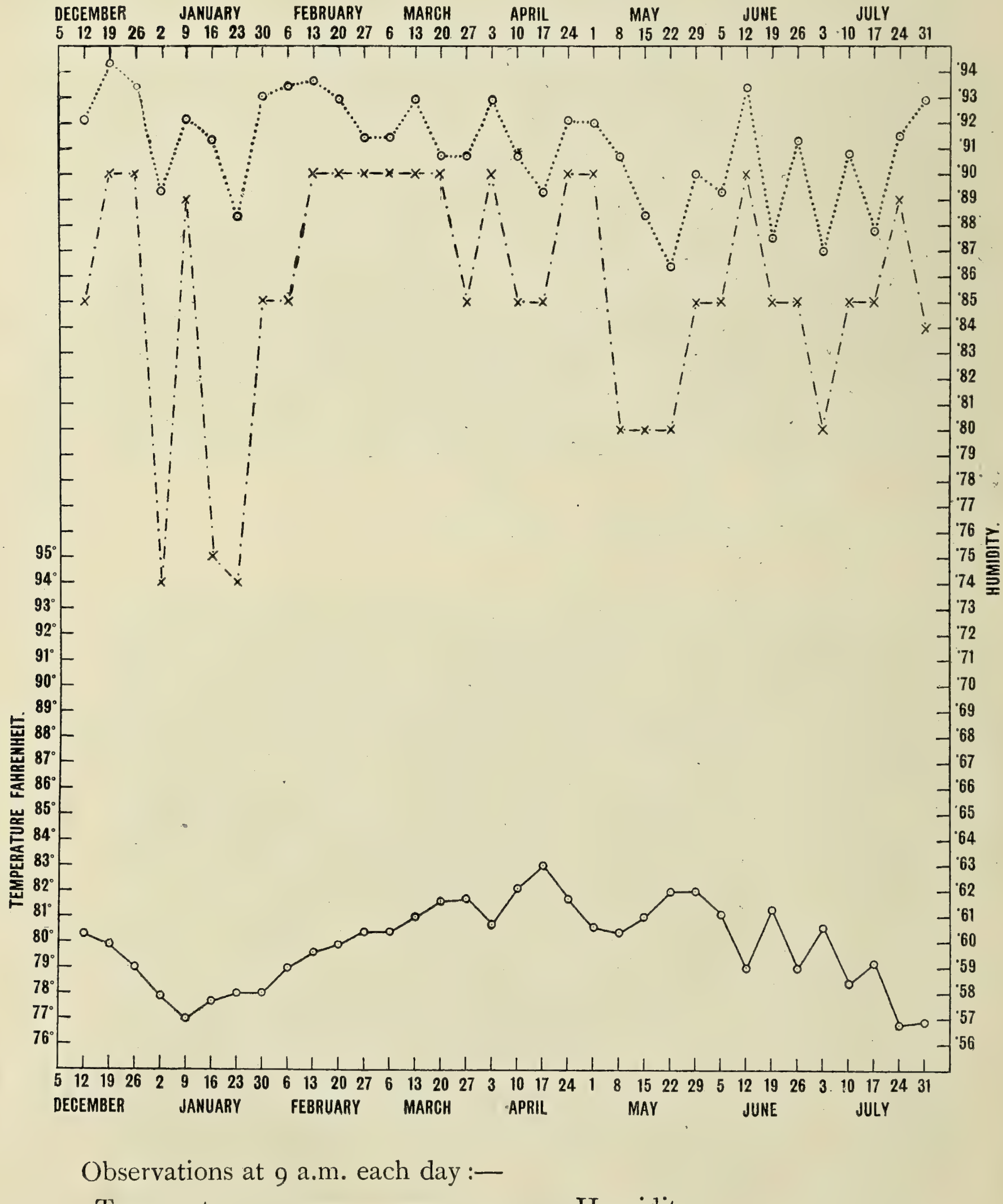


Temperature———————— Humidity . . . .

Minimum Humidity record in each week— · — · — · — ·

CHART No. 7.

CURVES OF TEMPERATURE AND HUMIDITY IN THE MOSQUITO HOUSE PIT.



Observations at 9 a.m. each day :—

Temperature ———————— Humidity . . . .

Minimum Humidity record in each week— · — · — · — ·

Well.—(Plate No. 22). This was covered, but owing to the larger air space it was better ventilated and less humid than the pit in the mosquito house.

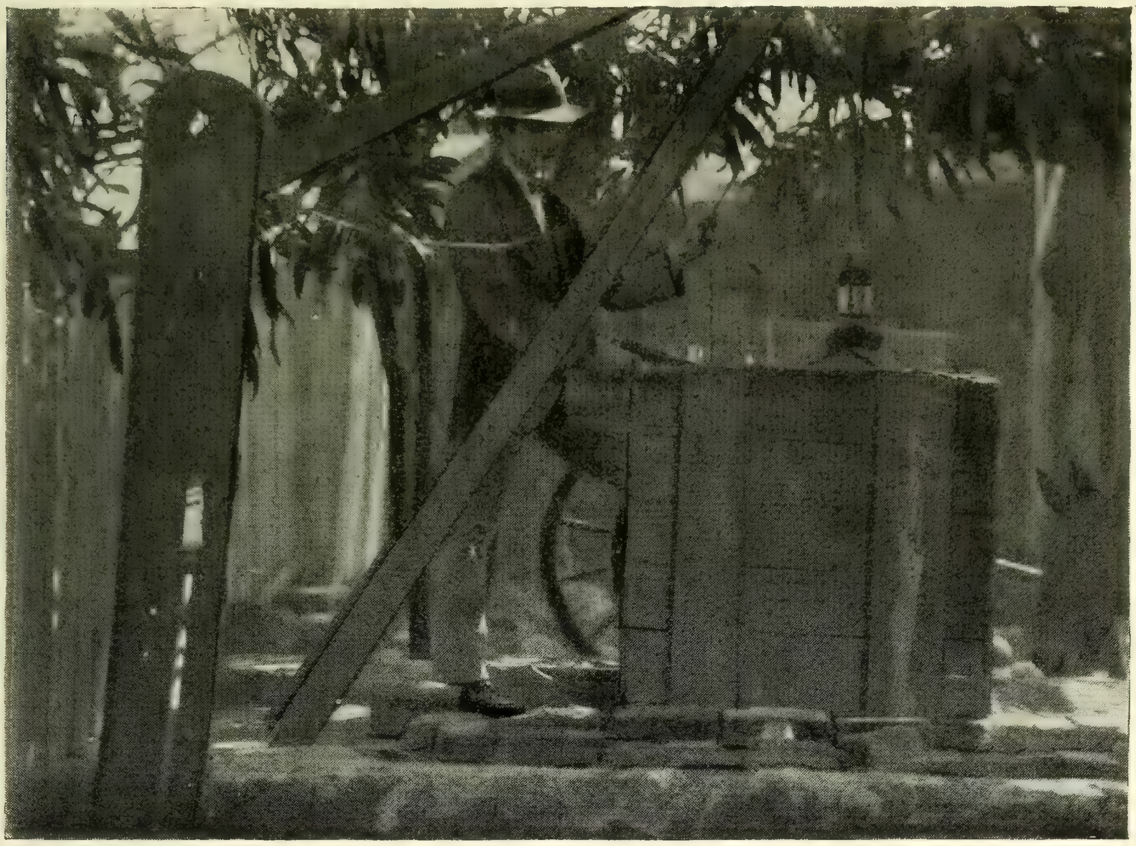


Plate No. 22.

Well in Sanitary Department Compound, showing method of suspending tubes containing adults under a tin of water to isolate from ants.

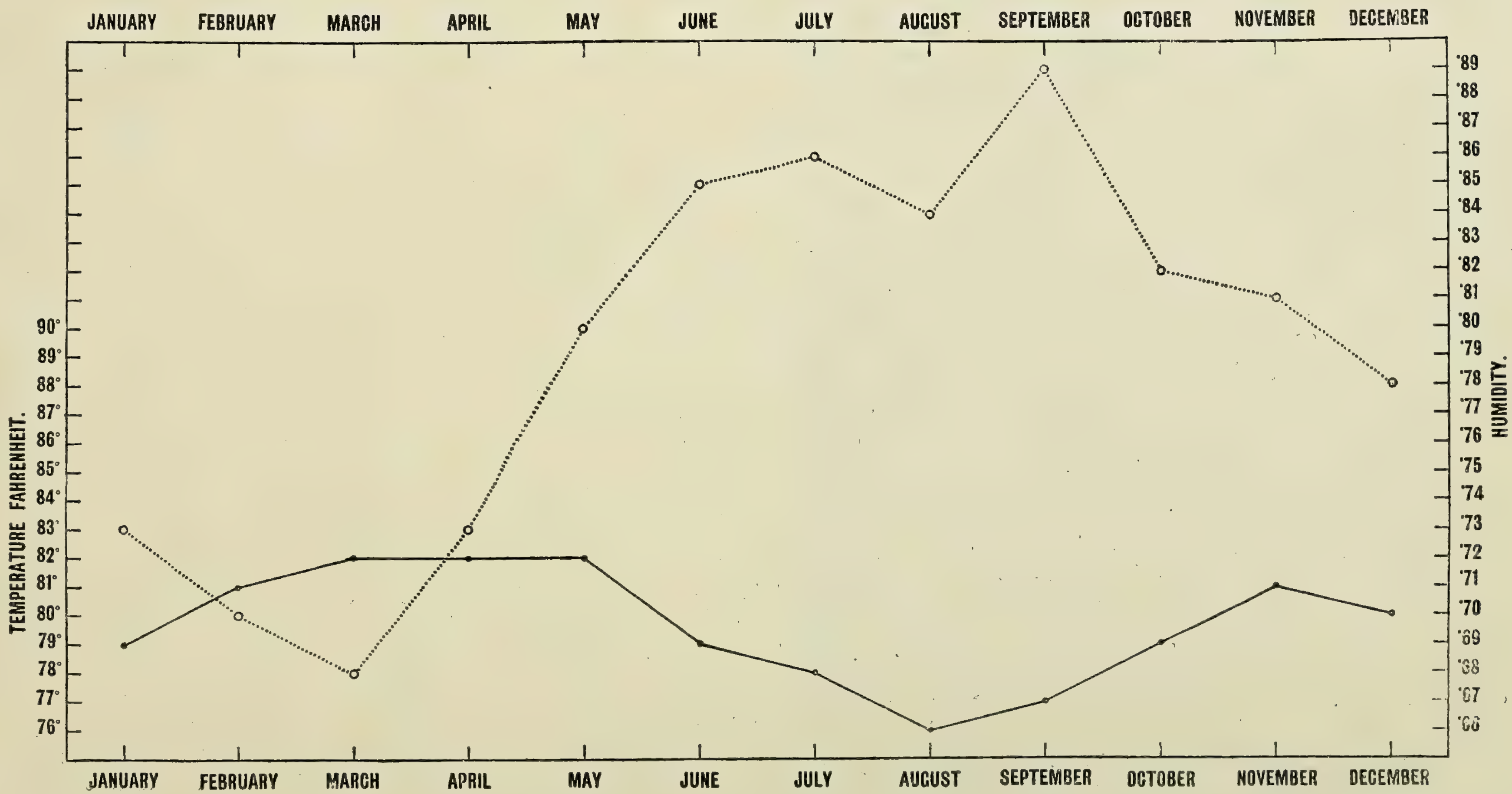
TEMPERATURE AND HUMIDITY RECORDS AT 3 FEET ABOVE WATER LEVEL IN THE WELL IN THE COMPOUND OF THE SANITARY DEPARTMENT, WATER STREET, FREETOWN.

Date.	Temperature.	Humidity.	Date.	Temperature.	Humidity.
21 December...	82° F.	...	3 March ...	83° F.	·85
23 " ...	82° "	·80	5 " ..	82° "	·90
26 " ...	81° "	·90	9 " ...	82° "	·90
			13 " ...	83° "	·80
			16 " ...	85° "	·76
18 January ...	81° "	·85	19 " ...	82° "	·90
21 " ...	82° "	·90			
25 " ...	80° "	·90	2 April ...	85° "	·72
28 " ...	80° "	·90	6 " ...	84° "	·80
			9 " ...	84° "	·80
			13 " ...	85° "	·76
1 February ...	80° "	·95	16 " ...	83° "	·90
4 " ...	80° "	·95	20 " ...	84° "	·80
8 " ...	81° "	·90	23 " ...	82° "	·90
26 " ...	82° "	·85	27 " ...	83° "	·85

Observations made at 10 a.m.

CHART No. 8.

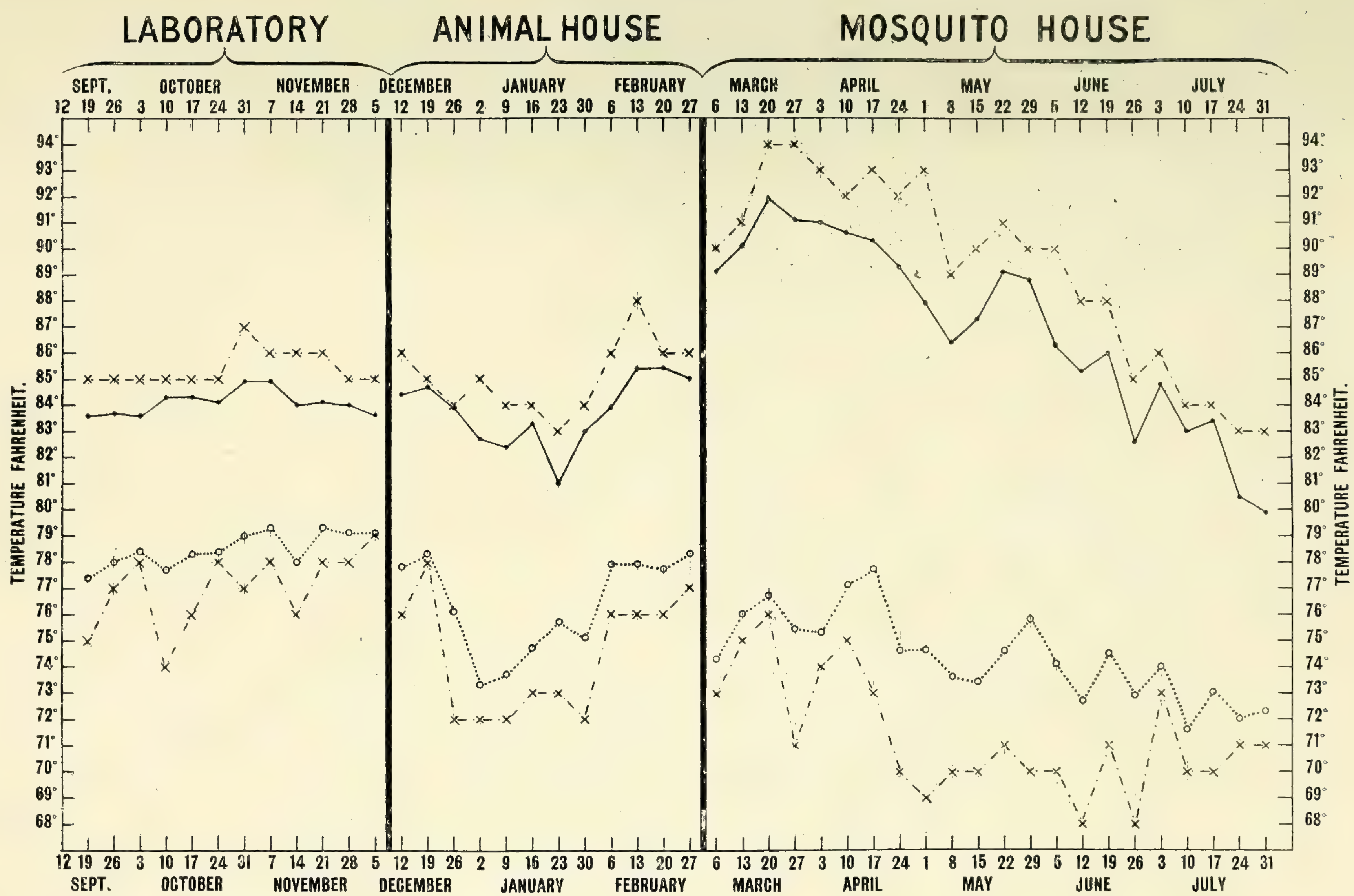
CURVES OF TEMPERATURE AND HUMIDITY AT THE METEOROLOGICAL STATION, FREETOWN, SIERRA LEONE (224 FEET ABOVE SEA LEVEL).



Observations at 9 a.m. Monthly means compiled from the Official Report for 1914.

CHART No 9.

CURVES OF MAXIMUM AND MINIMUM TEMPERATURES AND WEEKLY EXTREMES.



In the Laboratory from September 11th to December 4th; in the Animal House from December 4th to February 27th and in the Mosquito House from February 27th to July 31st.

Maximum Temperature———— Minimum Temperature . . . .
Extremes for each week— · — · — · — ·

The following tests were carried out in the above-mentioned situations, and the results were as follows:—

Yard at 26, Westmoreland Street.

Unfed.

141 emerged 23rd to 25th January. Period of experiment, 25th to 28th January. 71 males, 70 females.

85	lived	1 day	Average 1·4 days.
49	,,	2 days	
7	,,	3 ,,	
141			

Fed Honey.

91 emerged 16th to 18th December. Period of experiment, 18th to 28th December. 34 males, 57 females.

4	lived	5 days	All or nearly all males	Average 8·3 days.
4	,,	6 ,,		
41	,,	8 ,,		
33	,,	9 ,,		
9	,,	10 ,,		
91				

Fed Thin Syrup.

About 100 emerged 27th February to 1st March. Period of experiment, 1st to 15th March.

5	lived	1 day	Average 9·3 days.
4	,,	4 days	
3	,,	6 ,,	
5	,,	8 ,,	
24	,,	10 ,,	
6	,,	12 ,,	
9	,,	13 ,,	
56 *unfinished.*			

Ants got into the tube and carried off all that remained. To accomplish this they must have crossed a two-inch water surface or have dropped three inches from the roof of the pen on to the tube.

A Second Attempt.—114 emerged 2nd to 4th April. Period of experiment, 4th to 28th April.

5	lived	1	day	Average 8·6 days.
2	,,	2	days	
6	,,	3	,,	
2	,,	4	,,	
5	,,	6	,,	
16	,,	7	,,	
39	,,	8	,,	
15	,,	10	,,	
1	,,	11	,,	
13	,,	12	,,	
4	,,	15	,,	
4	,,	16	,,	
2	,,	24	,,	
114				

*Fed on Blood.**

15 minutes' opportunity for feeding given daily. 103 emerged 28th to 30th December. Period of experiment, 30th December to 7th February. 51 males, 52 females.

8	lived	1	day	Average 10·8 days.
6	,,	3	days	
4	,,	4	,,	
6	,,	5	,,	
14	,,	6	,,	
11	,,	7	,,	
7	,,	9	,,	
1	,,	10	,,	
6	,,	11	,,	
4	,,	14	,,	
16	,,	16	,,	
8	,,	17	,,	
2	,,	18	,,	
1	,,	19	,,	
1	,,	22	,,	
4	,,	23	,,	
2	,,	24	,,	
1	,,	35	,,	
1	,,	39	,,	
103				

* In tests when the mosquitoes are fed on blood, allowance must be made for the average being reduced by the early death of the males.

In Cage in Room at 26, Westmoreland Street.

Fed Honey.

42 emerged 25th to 26th November. Period of experiment, 26th November to 30th December. 16 males, 26 females.

16	lived	9	days	Average 12·3 days.
4	,,	10	,,	
9	,,	13	,,	
10	,,	15	,,	
1	,,	21	,,	
1	,,	22	,,	
1	,,	24	,,	
42				

Fed Honey.

75 emerged 22nd to 24th December. Period of experiment, 24th to 30th December. 9 males, 66 females.

3	lived	3	days	Average 4·6 days.
32	,,	4	,,	
32	,,	5	,,	
8	,,	6	,,	
75				

Hospital Compound. (Slight Shade.)

Unfed.

124 emerged 19th to 21st January. Period of experiment, 21st to 24th January. 39 males, 85 females.

9	lived	1	day	Average 2 days.
103	,,	2	days	
12	,,	3	,,	
124				

Fed Honey.

173 emerged 18th to 20th December. Period of experiment 20th to 26th December. 99 males, 74 females.

8	lived	2	days	Average 5·2 days.
7	,,	3	,,	
51	,,	4	,,	
87	,,	5	,,	
20	,,	6	,,	
173				

Fed on Blood.

15 minutes' opportunity given each day. 106 emerged 28th to 30th December. Period of experiment, 30th December to 18th January. 56 males, 50 females.

8	lived	3	days	23 of these were males.		Average 7·2 days.
22	"	4	"			
8	"	5	"			
17	"	6	"			
5	"	7	"			
18	"	8	"			
20	"	11	"	Feeding was omitted on 11th day.		
6	"	13	"			
1	"	16	"			
1	"	19	"			
106						

Mosquito House Pit.

Unfed.

About 100 emerged 17th to 19th January. Period of experiment, 19th to 31st January. Examination for sex omitted.

2	lived	4	days	Average 6·8 days.
34	"	5	"	
21	"	7	"	
37	"	8	"	
3	"	10	"	
3	"	12	"	
100				

Fed Honey.

About 100 emerged 7th to 9th January. Period of experiment, 9th January to 6th February. Sexes unrecognisable.

2	lived	8	days	Average 18·1 days.
21	"	15	"	
27	"	17	"	
9	"	18	"	
34	"	20	"	
3	"	24	"	
2	"	26	"	
2	"	28	"	
100				

Mosquito House—Suspended 2 inches Clear of Soil.

Fed Honey.

48 emerged 5th to 6th December. Period of experiment, 6th to 20th December. 22 males, 26 females.

3	lived	7	days	Average 9·2 days.
14	,,	8	,,	
10	,,	9	,,	
16	,,	10	,,	
2	,,	11	,,	
2	,,	12	,,	
1	,,	14	,,	
48				

Mosquito House—On Ground and Covered with Fallen Leaves.

Fed Honey.

100 emerged 18–20th December. Period of experiment, 20th December to 20th January. Within four days the ants had killed and carried away all but seven or eight. These were gradually killed off. Two managed to escape until the 9th of January.

Longest life, 20 days.

Mosquito House—Suspended 5 Feet from the Ground.

Fed Honey.

60 emerged 11th to 12th December. Period of experiment, 12th to 22nd December. 30 males, 30 females.

3	lived	1	day	Average 2·7 days.
27	,,	2	days	
27	,,	3	,,	
1	,,	4	,,	
2	,,	10	,,	
60				

Mosquito House Pit.

*Fed on Blood.**

At weekly intervals, no other food. About 100 emerged, 17th to 19th January. Period of experiment, 19th January to 8th February.

2	lived	4	days	Average 7·9 days.
23	”	5	”	
16	”	7	”	
38	”	8	”	
14	”	10	”	
2	”	12	”	
1	”	14	”	
1	”	16	”	
1	”	18	”	
2	”	20	”	
100				

Well in Sanitary Department Compound (about 20 to 25 feet to water level).

Lined masonry, about 6 or 8 feet, through surface soil, unlined through the solid laterite rock, diameter 5 to 6 feet. Tubes let down to within 3 feet of water.

Fed Honey.

About 100 emerged, 17th to 18th December. Period of experiment, 18th to 26th December.

There were never any dead, but tell-tale remnants of legs and wings showed that the ants were at work. All the specimens were killed and carried off within eight days.

Another attempt was made, an antiformica of suitable design being used.

About 100 emerged 13th to 14th January. Period of experiment, 14th January to 11th February.

6	lived	10	days	Average at least 17·8 days.
8	”	13	”	
46	”	17	”	
11	”	20	”	
20	”	24	”	
91				

The experiment was unfinished, as the cord rotted through, and the antiformica tube and contents were lost.

* Allowance must be made for the early death of the males which were present but in undetermined numbers.

Fed Thin Syrup.

About 100 emerged 24th to 26th February. Period of experiment, 26th February to 23rd March.

14	lived	7	days	
19	,,	11	,,	
16	,,	14	,,	Average 14·3 days.
43	,,	18	,,	
2	,,	21	,,	
94				

The experiment was unfinished, as the rope rotted through, and the antiformica and tubes with it were lost.

A later attempt was made, copper wire being used in place of rope.

About 100 emerged 31st March to 2nd April. Period of experiment, 2nd to 27th April.

5	lived	4	days	
18	,,	7	,,	
47	,,	11	,,	
18	,,	14	,,	Average 11·3 days.
8	,,	16	,,	
2	,,	21	,,	
2	,,	25	,,	
100				

Given One Meal of Blood, then Fed on Syrup.

About 100 emerged 24th to 26th February. Period of experiment, 26th February to 19th March.

10	lived	7	days	
39	,,	11	,,	
3	,,	14	,,	Average 13·4 days.
30	,,	18	,,	
2	,,	21	,,	
84				

Experiment was unfinished, as the rope rotted through.

Another attempt was made, wire replacing the rope.

About 100 emerged 31st March to 2nd April. Period of experiment, 2nd to 23rd April.

4	lived	4	days	
18	,,	7	,,	
38	,,	11	,,	Average 11·8 days.
25	,,	14	,,	
14	,,	18	,,	
1	,,	21	,,	
100				

ANIMAL HOUSE—SUSPENDED ABOUT 2 FEET ABOVE FLOOR

Fed Honey.

51 emerged 9th to 10th December. Period of experiment, 10th to 18th December.

4	lived	3	days	Average 5·7 days.
8	,,	4	,,	
31	,,	6	,,	
8	,,	8	,,	
51				

Experiment No. XXXVI.

LENGTH OF LIFE OF MALES AND FEMALES WHEN FED ON BANANAS ONLY.

A little water was added if the banana was not juicy. Kept in a H.L.C.* cage over *wet* filter paper. Emerged 17th to 19th March.

Date of death.	Males.	Females.	Number of days after emergence.	Remarks.
20 March	1 dead	Nil	1	
21 ,,	6 ,,	1 dead	2	
22 ,,	Nil	1 ,,	3	
23 ,,	1 dead	2 ,,	4	
26 ,,	1 ,,	2 ,,	7	
28 ,,	Nil	3 ,,	9	
29 ,,	1 dead	1 ,,	10	
30 ,,	3 ,,	Nil	11	
31 ,,	6 ,,	2 dead	12	
1 April	4 ,,	...	13	
2 ,,	2 ,,	3 dead	14	
4 ,,	3 ,,	2 ,,	16	
6 ,,	1 ,,	3 ,,	18	
7 ,,	Nil	1 ,,	19	
8 ,,	1 dead	Nil	20	
9 ,,	1 ,,	2 dead	21	
10 ,,	1 ,,	2 ,,	22	
11 ,,	1 ,,	6 ,,	23	
13 ,,	Nil	2 ,,	25	
14 ,,	,,	2 ,,	26	
18 ,,	,,	1 ,,	30	
21 ,,	,,	1 ,,	33	
24 ,,	,,	1 ,,	36	
26 ,,	,,	1 ,,	38	
27 ,,	,,	1 ,,	39	
30 ,,	,,	1 ,,	42	
4 May	,,	1 ,,	46	
	33	42		

Average life: males 10·9 days; females 19·6 days.
Longest ,, ,, 23 ,, ,, 46 ,,

* Cage made out of a hurricane lamp chimney. See illustration, page 175.

Experiment No. XXXVII.

LENGTH OF LIFE OF MALES AND FEMALES FED ON SYRUP ONLY.

Kept in a H.L.C. cage over *wet* filter paper. Emerged 17th to 19th February.

Date of death.	Males.	Females.	Number of days after emergence.	Remarks.
20 February	1 dead	Nil	1	
28 "	2 "	1 dead	9	
1 March	5 "	2 "	10	Under these moist conditions the insects are prone to get their legs smeared with syrup, and this causes a certain amount of mortality.
2 "	1 "	1 "	11	
3 "	1 "	Nil	12	
4 "	1 "	"	13	
6 "	2 "	"	15	
7 "	2 "	"	16	
8 "	1 "	1 dead	17	
11 "	1 "	4 "	20	
12 "	3 "	1 "	21	
14 "	2 "	Nil	23	
15 "	4 "	3 dead	24	
16 "	Nil	15 " *	25	*A tiny leak in the syrup pan led to a high concentration, which may have been partly responsible for this sudden increase in the death rate.
17 "	1 dead	7 "	26	
18 "	Nil	1 "	27	
19 "	1 dead	3 "	28	
20 "	Nil	2 "	29	
21 "	"	1 "	30	
23 "	"	2 "	32	
31 "	"	1 "	40	
5 April	"	1 "	45	
7 "	"	1 "	47	
9 "	"	1 "	49	
10 "	1 dead	Nil	50	
21 "	Nil	1 dead	60	
	29	49		

Average life: males, 17·6 days; females, 26·3 days.
Longest " : " 50 " ; " 60 "

Experiment No. XXXVIII.

LENGTH OF LIFE OF MALES AND FEMALES FED ON SYRUP ONLY (BOILED WATER AND TATE CUBE SUGAR).

Kept in a H.-L.C. cage over *dry* filter paper. Emerged 10th to 12th February.

Date of death.	Males.	Females.	Number of days after emergence.	Remarks.
13 February	Nil	1 dead	1	
18 ,,	1 dead	Nil	6	
24 ,,	1 ,,	,,	12	
6 March	1 ,,	,,	22	
7 ,,	1 ,,	,,	23	
8 ,,	1 ,,	1 dead	24	
11 ,,	4 ,,	Nil	27	
12 ,,	Nil	1 dead	28	
13 ,,	1 dead	Nil	29	
15 ,,	Nil	1 dead	31	
16 ,,	2 dead	Nil	32	
17 ,,	1 ,,	,,	33	
18 ,,	Nil	1 dead	34	
19 ,,	3 dead	2 ,,	35	
20 ,,	1 ,,	3 ,,	36	
22 ,,	1 ,,	1 ,,	38	
23 ,,	Nil	2 ,,	39	
24 ,,	,,	2 ,,	40	
25 ,,	1 dead	Nil	41	
26 ,,	1 ,,	1 dead	42	
27 ,,	Nil	1 ,,	43	
28 ,,	,,	1 ,,	44	
31 ,,	,,	4 ,,	47	
1 April	,,	2 ,,	48	
2 ,,	,,	2 ,,	49	
4 ,,	,,	2 ,,	51	
7 ,,	,,	1 ,,	54	
9 ,,	,,	1 ,,	56	
11 ,,	,,	1 ,,	58	
12 ,,	,,	1 ,,	59	
14 ,,	,,	1 ,,	61	
16 ,,	,,	1 ,,	63	
21 ,,	,,	1 ,,	68	
	20	35		

Average life : males, 29 days ; females, 44·1 days.
Longest ,, : ,, 42 ,, ; ,, 68 ,,

Experiment No. XXXIX.

RELATIVE LENGTH OF LIFE OF MALES AND FEMALES FED ON HONEY ONLY.

Kept in a H.L.C. cage over *wet* filter paper. Emerged 24th to 25th November.

Date of death.	Males.	Females.	Number of days after emergence.	Remarks.
7 December	1 dead	Nil	12	
14 "	2 "	"	19	
18 "	1 "	2 dead	23	
19 "	Nil	2 "	24	
20 "	"	1 "	25	
21 "	"	2 "	26	
22 "	"	3 "	27	
24 "	2 dead	1 "	29	
25 "	Nil	1 "	30	
27 "	"	2 "	32	
28 "	"	1 "	33	
29 "	"	2 "	34	
30 "	"	1 "	35	
31 "	"	1 "	36	
4 January	"	1 "	40	
6 "	"	1 "	42	
12 "	"	1 "	48	
15 "	"	1 "	51	
17 "	"	1 "	53	
	6	24		

Average life: males 21·8 days; females 32·5 days.
Longest " : " 29 " ; " 53 "

Experiment No. XL.

RELATIVE LENGTH OF LIFE OF MALES AND FEMALES FED ON HONEY ONLY.

Kept in a H.L.C. cage, over *dry* filter paper. Emerged 3rd to 5th January.

Date of Death.	Males.	Females.	Number of days after emergence.	Remarks.
6 January	1 dead	Nil	1	
7 "	2 "	"	2	
8 "	Nil	1 dead	3	
9 "	10 dead	9 "	4	
10 "	1 "	4 "	5	
16 "	1 "	Nil	11	
18 "	1 "	1 dead	13	
19 "	Nil	1 "	14	
20 "	4 dead	3 "	15	
21 "	2 "	1 "	16	
22 "	2 "	1 "	17	
23 "	5 "	6 "	18	
24 "	Nil	3 "	19	
29 "	"	1 "	24	
	29	31		

Average life: males 10 days; females 11·4 days.
Longest ": " 18 "; " 24 "

Experiment No. XLI.

EGG PRODUCTION AFTER A SINGLE MEAL OF BLOOD, AND EVIDENCE OF THE EGG RETAINING HABIT, AND ALSO SHOWS COMPARATIVE LENGTH OF LIFE OF MALES AND FEMALES.

A number of males and females which emerged on the 1st to 3rd December were allowed free intercourse in a large cage. The females were given an opportunity of feeding on human blood; those that filled themselves to repletion were selected for the experiment. Twelve males and 23 females were transferred to a H.T.C. cage with *wet* filter paper at base, and supplied liberally with honey.

Date of deposition of eggs or death.	Number of eggs laid.	Fertility.	Death of males.	Death of females.	Number of days after meal of blood.	Remarks.
4 December	61	+	...	...	2	The number of eggs laid presupposes that only two or at the most three females were laying.
5 ,,	51	+	...	...	3	
6 ,,	5	+	...	...	4	
7 ,,	148	+	...	...	5	
8 ,,	4	+	...	...	6	
9 ,,	11	+	...	...	7	
10 ,,	...		1 dead	...	8	
12 ,,	5	+	...	2 dead	10	
13 ,,	4	+	...	1 ,,	11	
14 ,,	1	+	...	1 ,,	12	
15 ,,	13	+	1 dead	...	13	
17 ,,	...	...	4 ,,	...	15	
20 ,,	...	...	1 ,,	...	18	
21 ,,	41	+	1 ,,	...	19	
22 ,,	1	+	...	1 dead	20	
25 ,,	4	+	...	...	23	
26 ,,	31	+	1 escaped	2 dead	24	
27 ,,	11	+	...	3 ,,	25	
28 ,,	1	+	2 dead	...	26	
29 ,,	1	+	...	1 dead	27	
30 ,,	32	+	...	...	28	
31 ,,	4	+	...	...	29	
1 January	19	+	...	1 dead	30	
2 ,,	...	...	...	1 ,,	31	
5 ,,	170	+	...	...	34	
6 ,,	13	+	...	1 dead	35	
7 ,,	...	...	...	1 ,,	36	
8 ,,	...	...	1 dead	...	37	
9 ,,	...	...	...	2 dead	38	
11 ,,	105	+	...	1 ,,	40	
16 ,,	3	−	...	...	45	
20 ,,	...	...	...	1 dead	49	
25 ,,	...	...	...	3 ,,	54	
13 February	...	...	...	*1 ,,	73	

* The ovaries of this female on dissection proved to be fully developed and the eggs ripe for laying, many of them being already brown. It is significant that this should be the case 70 days after the only meal of blood she received.

Average life : 12 males 18·8 days ; 23 females 32·3 days.
Longest ,, : ,, ,, 37 ,, ; ,, ,, 73 ,,

Experiment No. XLII.

EVIDENCE OF EGG RETAINING HABIT AND LENGTH OF LIFE AFTER A SINGLE MEAL OF BLOOD (SUBSEQUENT FOOD HONEY).

Females which emerged on the 5th, 6th, 7th, 8th and 9th December were kept for 24 hours in a cage with a number of males, they were then allowed one full meal of blood (Nos. 1, 2, 3, 4 and 5 on the 7th December, Nos. 6, 7 and 8 on the 9th December, Nos. 9, 10 and 11 on the 10th December). Each female was then placed in a separate jar with *wet* filter paper at the bottom and fed on honey.

Date of deposition of eggs or death.	Identification number.	Number of eggs laid.	Fertility.	Death.	Number of days after meal of blood.	Remarks.
8 December	2	...	...	died	1	
10 ,,	4	69	+	...	3	
,,	5	46	+	...	3	
11 ,,	4	1	...	...	4	No record of hatching.
,,	5	1	..	...	4	,, ,, ,, ,,
,,	6	71	+	...	2	
,,	8	13	+	...	2	
12 ,,	5	1	...	...	5	No record of hatching.
,,	6	1	...	...	5	,, ,, ,, ,,
,,	8	52	+	...	3	
,,	9	1	...	...	3	No record of hatching.
,,	10	60	+	...	2	
,,	11	38	+	...	2	
13 ,,	4	4	+	...	6	
,,	6	1	...	...	4	No record of hatching.
15 ,,	11	2	...	...	5	,, ,, ,, ,,
16 ,,	3	...	...	escaped	9	Laid no eggs.
17 ,,	6	1	+	...	8	
,,	9	1	+	...	7	
,,	11	2	+	...	7	
18 ,,	7	...	...	died	9	Laid no eggs.
19 ,,	4	2	+	...	12	
20 ,,	5	...	...	died	13	
,,	9	2	+	...	10	
,,	11	2	+	...	10	
26 ,,	6	...	...	died	17	
31 ,,	10	...	...	,,	21	
1 January	11	...	...	,,	22	
2 ,,	9	1	+	...	23	
6 ,,	8	1	–	...	28	Egg infertile.
,,	9	2	+	...	28*	*These eggs resisted immersion. After three months' dry storage one of them retained its shape but did not hatch in spite of a long period in water. On the 26th April it was opened and found to contain a living larva.
10 ,,	8	...	...	died	32	
13 ,,	1	...	...	,,	37	
24 ,,	9	1	infertile	...	46	
26 ,,	4	...	...	died	50	
1 February	9	...	...	,,	53	

Average life : 25·6 days ; longest life : 53 days.

Experiment No. XLIII.

TEST TO ASCERTAIN IF WELL-FED FEMALES WOULD OVIPOSIT APART FROM WET SURFACES, AND THEIR LENGTH OF LIFE WHEN EGGS HAVE TO BE RETAINED OWING TO DROUGHT.

Females that emerged between the 20th and 29th December were allowed free intercourse with a number of males in a large cage.

Those which fed readily on a human arm were selected and placed in a H.T.C. cage based on *dry* filter paper, the top covered with fine gauze; no additional cover being used to prevent evaporation.

A supply of honey was kept in the cage, and a ten minutes' opportunity of taking human blood was afforded each night.

Date of deposition of eggs or death.	Number of eggs laid.	Fertility.	Death.	Number of days after first meal of blood.	Remarks.
31 December	1	infertile	1	2	
2 January	...	...	1	4	
7 "	...	...	1	9	
8 "	...	...	3	10	
9 "	...	...	3	11	
22 "	...	...	1	24	
23 "	...	...	6	25	
24 "	...	...	1	26	
25 "	...	...	1	27	
29 "	...	...	1	31	
30 "	...	...	1	32	
31 "	...	...	1	33	
1 February	...	...	2	34	
2 "	...	...	1	35	
3 "	...	...	2	36	
4 "	...	...	1	37	
5 "	...	...	2	38	
7 "	...	...	3	40	
8 "	...	...	2	41	
11 "	...	...	1	44*	*This female when dying was placed in a small tube with a piece of *wet* filter paper. She immediately commenced to oviposit and laid a small batch of *infertile* eggs.
5 March	...	...	1	66	
12 "	...	...	1	73	
13 "	...	...	2	74	
			39		

Average life, 31·3 days; longest life, 74 days.

Only one infertile egg was laid on dry paper, although a dying female laid at once when provided with a wet surface.

CONCLUSION: *Water or wet surfaces* are essential to egg laying.

Experiments Nos. XLI. and XLII. It will be noted that female No. 1 lived 37 days but died without ovipositing, while Nos. 3 and 7 also failed to lay any eggs. Unfortunately, time did not permit of the dissection of Nos. 1 and 7 to ascertain if their ovaries were ripe, or if they were awaiting further meals of blood before developing them. It seems more probable, however, that the eggs were being retained.

The oviposition of females Nos. 4, 5, 6, 8, 10, and 11 was not very unusual, but that of No. 9 was distinctly abnormal, in that she dribbled out pairs or single eggs at long intervals. Those laid 23 and 28 days after the initial meal of blood proved to be fertile. Time did not permit of her dissection.

If the two experiments are considered together there seems to be a strong case made out for the instinctive retention of eggs by a proportion of the females, and this is probably the explanation why certain females in earlier experiments failed to lay, although they were afforded opportunities of sucking human blood every night.

TWO EXPERIMENTS TO ILLUSTRATE EGG PRODUCTION AND LAYING, APART FROM FEEDING ON A LIVING ANIMAL.

Attempts were made to induce egg production by feeding on mixtures of honey and white of egg, honey and dried blood, honey and fresh blood, syrup and fresh blood.

Honey and white of egg kept well in a stoppered jar for three weeks, but fermented within a day or two when placed in the cage for the females to feed on. Honey and dried blood did not keep well, possibly owing to water being used to mix the blood into a paste before adding it to the honey.

Honey and fresh blood and syrup and fresh blood kept for months when placed in a desiccator to cause a high concentration of sugar.

The first attempts with honey and white of egg, honey and dried blood, and honey and fresh blood were all negative. Some 50 to 100 females were used in each case, equal or larger numbers of males being kept with them. Pairing took place freely but the ovaries never developed, although the average life was considerable. The sole surviving female in one of the experiments, after living for 56 days, was given the opportunity of sucking human blood. She fed sparingly on three successive nights, then missed a night, and laid 21 fertile eggs on the following night. After depositing the eggs she bit but did not obtain blood, and died the next day. Two attempts, Experiments Nos. XXIV. and XXV., were then made, in one, honey

and fresh blood from a sheep was again used, in the other, syrup and fresh blood from a sheep. As will be seen from the following records both met with sufficient success to be of interest theoretically, but so modified as to afford little hope of the method proving of any practical assistance in future research.

Experiment No. XLIV.

A number of males and females, which emerged on the 13th and 14th January, were placed in a hurricane lamp chimney cage on *wet* filter paper, and given an ample supply of honey mixed with blood from a sheep. This was changed on the first signs of fermentation.

Date of deposition of eggs or deaths.	Number of eggs laid.	Fertility.	Death of males.	Death of females.	Number of days after start.	Remarks.
17 January	...	...	4 dead	2 dead	3	
18 ,,	...	...	3 ,,	Nil	4	
19 ,,	...	...	Nil	1 dead	5	
20 ,,	...	...	3 dead	1 ,,	6	
22 ,,	...	...	2 ,,	Nil	8	
23 ,,	...	...	1 ,,	,,	9	
24 ,,	...	...	2 ,,	,,	10	
25 ,,	...	...	2 ,,	,,	11	
27 ,,	...	...	4 ,,	,,	13	
28 ,,	...	...	1 ,,	,,	14	
30 ,,	...	...	4 ,,	5 dead	16	
31 ,,	...	...	3 ,,	Nil	17	
1 February	...	...	7 ,,	,,	18	
2 ,,	...	...	1 ,,	,,	19	
3 ,,	...	...	6* ,,	4*dead	20	*Most of these died from mechanical causes, their legs getting fixed in the sticky mixture owing to rapid drying.
4 ,,	...	...	Nil	2 ,,	21	
5 ,,	...	...	1 dead	2 ,,	22	
6 ,,	...	...	1 ,,	3 ,,	23	
7 ,,	...	...	1 ,,	3 ,,	24	
8 ,,	...	...	1 ,,	1 ,,	25	
9 ,,	...	...	Nil	1 ,,	26	
10 ,,	...	...	,,	2 ,,	27	
11 ,,	...	...	,,	2 ,,	28	
12 ,,	...	...	,,	1 ,,	29	
13 ,,	...	...	1 dead	1 ,,	30	
16 ,,	...	...	Nil	1 ,,	33	
17 ,,	...	...	1 dead	1 ,,	34	
19 ,,	...	...	Nil	2 ,,	36	
24 ,,	...	...	,,	1 ,,	41	
25 ,,	...	...	,,	1 ,,	42	
27 ,,	...	...	,,	2 ,,	44	
28 ,,	...	...	,,	1 ,,	45	
1 March	...	...	,,	1 ,,	46	
2 ,,	1	*Infertile*	,,	Nil	47	
7 ,,	...	...	,,	1 dead	52	
12 ,,	...	...	,,	1 ,,	57	
12 April	...	...	,,	1 ,,	88	
			49	44		

Result.—1 infertile egg.
Average life : males, 14·6 days ; females, 27·8 days.
Longest ,, : ,, 34 ,, ; ,, 88 ,,

Experiment No. XLV.

A number of males and females which emerged on the 1st and 2nd March were placed in a H.L.C. cage over *wet* filter paper and given an ample supply of syrup mixed with blood from a sheep. The supply was changed on the first sign of fermentation.

Date of deposition of eggs or death.	Number of eggs laid.	Fertility.	Death of males.	Death of females.	No. of days from start.	Remarks.
4 March	1	+	...	2 dead	2	The egg hatched on 7th March.
5 ,,	...	...	1 dead	Nil	3	
6 ,,	...	...	6 ,,	,,	4	
7 ,,	...	...	1 ,,	,,	5	
8 ,,	...	...	2 ,,	,,	6	
9 ,,	...	...	3 ,,	,,	7	
11 ,,	...	...	2 ,,	2 dead	9	
12 ,,	...	...	Nil	2 ,,	10	
14 ,,	...	...	1 dead	1 ,,	12	
15 ,,	...	...	2 ,,	Nil	13	
16 ,,	...	...	1 ,,	1 dead	14	
17 ,,	...	...	1 ,,	3 ,,	15	
20 ,,	...	...	Nil	1 ,,	18	
22 ,,	...	...	2 dead	3 ,,	20	
23 ,,	...	...	1 ,,	1 ,,	21	
24 ,,	...	...	1 ,,	Nil	22	
25 ,,	...	...	Nil	2 dead	23	
26 ,,	...	...	1 dead	2 ,,	24	
27 ,,	...	...	1 ,,	4 ,,	25	
28 ,,	...	...	1 ,,	1 ,,	26	
29 ,,	...	...	1 ,,	3 ,,	27	
30 ,,	...	...	1 ,,	2 ,,	28	
1 April	...	...	2 ,,	5 ,,	30	
2 ,,	...	...	3 ,,	1 ,,	31	
3 ,,	...	...	1 ,,	1 ,,	32	
5 ,,	...	...	Nil	1 ,,	34	
6 ,,	...	...	,,	2 ,,	35	
8 ,,	...	...	,,	1 ,,	37	
19 ,,	...	...	,,	2 ,,	48	
27 ,,	...	...	,,	1 ,,	56	
30 ,,	...	...	,,	3 ,,	59	
1 May	...	...	,,	1 ,,	60	
3 ,,	...	...	,,	2 ,,	62	
4 ,,	...	...	,,	1 ,,	63	
5 ,,	...	...	,,	2 ,,	64	
13 ,,	...	...	,,	1 ,,	72	
27 ,,	...	...	,,	1 ,,	86	
			35	55		

Result: 1 fertile egg.

Average life: males, 15·6 days; females, 32·5 days.
Longest ,, ,, 32 ,, ,, 86 ,,

Experiments Nos. XLVI. and XLVII.

FERTILITY OF MALES AND THE SURVIVAL OF SPERMATOZOA IN THE SPERMATHECÆ OF THE FEMALE (*STEGOMYIA FASCIATA*).

In these experiments, Nos. XLVI. and XLVII., the main object was to determine how many females a single male is able to impregnate and the scope of the ability to fertilize eggs which is imparted.

The longest time between pairing and the laying of fertile eggs which was observed during the progress of the research was 62 days—on the part of the female used in Experiment No. VII. This period was but a portion of her active productive life; while it lasted she laid 711 eggs in 15 batches. Subsequently she lived a further 29 days and laid 6 batches, containing 89 infertile eggs. In another experiment (No. XLI.) fertile eggs were laid 40 days after impregnation, which had been effected prior to the only meal of blood the insects received.

Neither of these cases can compare with Goeldi's classic example of the retention of spermatozoa for 102 days; nor are they, strictly speaking, comparable, because Goeldi's specimen only received the meal of blood necessary for the development of her eggs towards the close of her segregation.

Three experiments were attempted; the first was a complete failure owing to the escape of the male after pairing with two females. The second trial came to an untimely end with the death of the male after 7 days, during which period he fertilized 4 out of 5 females placed with him on successive days.

The third attempt promised better success, as the male lived 21 days and fertilized, more or less effectually, 10 of the 21 females that were placed with him. The females, however, proved to be very poor egg producers and of low vitality generally. This may have been due to underfeeding in the larval stage, as they were drawn from a very large brood at a period of the research when the amount of food required by the larvæ had not received proper attention. On the other hand, the small egg-laying capacity may have been a matter of heredity. It was certainly not due to want

of food in the adult stage, as they all had nightly opportunities, and, for the most part, fed as regularly as females which laid much larger batches of eggs.

Another factor which acted to the detriment of the experiment was attacks by ants. It was only towards the close of the series that it was discovered that inequalities in the rims of some of the jars used allowed the small yellow house ants, *Monomorium pharaonis L.*, to gain entrance. The disappearance of females and possibly a considerable percentage of the mortality is to be ascribed to this cause. If, however, the second and third attempts (Experiments Nos. XLVI. and XLVII.) are considered in conjunction, a fair idea of the scope of the males' ability in the matter of impregnation will be obtained.

Some allowance must be made for mortality among the fertilized eggs, which did not perhaps receive the most favourable treatment, but this source of error was minimised as far as possible by dissecting those eggs which failed to hatch on re-immersion after three months' dry storage, the number of those which contained developed larvæ being added to those which had already hatched. In several instances *living* larvæ were extracted from the eggs, but in most cases they were dead. In doubtful cases where full development of the larvæ was not demonstrated by the presence of the egg breaker on its head, the eggs were passed as infertile.

An appended table gives the record of the eggs laid by female No. III. in Experiment No. XLVI. in full detail.

Experiment No. XLVI.

FERTILITY TEST WITH *STEGOMYIA FASCIATA.*

The *male emerged 25th October, and died 1st November.

The females after feeding were placed with the male in rotation.

Female.	Date of emergence.	Date with male.	Started to lay.	Batches of eggs laid.												Total number laid.	Number of eggs which hatched or developed to larvæ in the respective batches.												Total number hatched.	Percentage of fertilized eggs.	Close of experiment.
				1	2	3	4	5	6	7	8	9	10	11	12		1	2	3	4	5	6	7	8	9	10	11	12			
I.	24 Oct.	25 Oct.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	5 Dec.
II.	25 ,,	26 ,,	30 Oct.	9	35	...	...	...	...	...	...	...	...	...	...	44	2	13	...	...	...	...	...	...	...	...	...	...	15	34	3 Nov.
III.†	27 ,,	27 ,,	30 ,,	91	86	80	59	85	86	77	84	63	53	41	32	837	86	55	73	59	63	67	76	76	51	42	4	28	680	81	3 Dec.
IV.	27 ,,	28 ,,	8 Nov.	5	28	77	...	...	...	...	...	...	...	...	...	110	4	28	23	...	...	...	...	...	...	...	...	...	55	50	14 Nov.
V.	27 ,,	29 ,,	2 ,,	15	40	84	...	...	...	...	...	...	...	...	...	139	0	0	3	...	...	...	...	...	...	...	...	...	3	2	21 ,,
VI.	30 ,,	30 ,,	14 ,,	9	...	...	...	...	...	...	...	...	...	...	...	9	0	...	...	...	...	...	...	...	...	...	...	...	0	...	15 ,,
																1,139													753	66	

* Bred from egg laid 14th September, which was immersed until 15th October without hatching, was then dried and returned to the water; it hatched the same day; the larva pupated 23rd October.

† Detailed account of hatching appended.

REMARKS.—I., died without egg laying, although she fed well at frequent intervals; II. and III., found dead; IV., killed through an accident; V. and VI., found dead.

DETAILS OF THE LAYING AND HATCHING OF THE EGGS OF FEMALE No. III.

NOTE.—The number of eggs laid each day are given, and not in batches as in the experiment itself. The method employed was to allow the eggs to incubate in glass tubes on damp paper for from 2 to 5 days, the tubes being uncorked to allow gradual drying after the second day. Eggs immersed within two days were not dried at all.

Date of laying.	Number laid.	Reference number.	Dates of hatching. November. 1	2	3	4	5	6	8	9	11	12	13	16	17	18	19	21	26	27	29	30	December. 2	3	4	8	15	Total number which hatched.	Percentage which hatched.	Living larvæ extracted from eggs, 29th April	Dead larvæ extracted from eggs.	Percentage of fertility.
30 Oct.	91	1	1	30	3	40	10	2	...	...	...	...	...	...	...		...	...	...	...	...	...	...	...	...	...	...	86	95	...	...	95
1 Nov.	2	2	...	...	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2	100	...	...	100
2 ,,	84	3	...	...	...	1	...	46	...	...	...	...	...	...	...	...	...	...	...	...	...	...	5	...	...	...	1	53	63	...	..	63
5 ,,	80	4	...	...	...	...	...	...	54	11	...	...	...	...	...	...	...	...	...	...	...	...	1	...	1	...	...	67	84	...	6	91
8 ,,	59	5	...	...	...	...	...	...	...	...	34	24	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	59	100	...	...	100
11 ,,	84	6	...	...	...	...	...	...	...	...	...	...	...	34	5	...	...	...	...	...	...	...	...	...	...	...	...	39	42	...	24	75
12 ,,	1	7	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	0	...	...	...	...
13 ,,	2	8	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	0	...	...	...	...
14 ,,	84	9	...	...	...	...	...	...	...	...	...	...	...	...	...	27	31	...	...	...	...	...	...	...	...	...	...	58	69	1	8	78
17 ,,	77	10	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	76	...	...	...	...	...	...	...	...	...	76	98	...	...	98
20 ,,	84	11	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	75	1	...	..	...	...	...	...	...	76	90	...	...	90
24 ,,	63	12	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	30	2	...	...	...	...	...	32	51	1	18	81
27 ,,	53	13	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	42	...	...	...	42	79	.	...	79
30 ,,	41	14	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	0	...	...	4	10
3 Dec.	32	15	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	28	...	28	87	...	...	87
	837																											618	73	2	60	81

NOTES.—1. On the 4th November the batch was dried and again immersed. 3. On the 2nd December the batch was placed in the rain and afterwards immersed in cool rain water. 4. When immersed on the 8th November several hatched within 5 minutes and 54 within one hour. On the 2nd December the batch was placed in the rain and afterwards immersed in cool rain water. 5. When immersed on the 11th November 34 hatched within 2 hours. 9. When immersed on the 18th November 23 hatched within one hour.

Experiment No. XLVII.

FERTILITY TEST WITH *STEGOMYIA FASCIATA*.

The male emerged on the 1st November, and died on the 22nd of the same month. The females were fed twice or thrice before they were placed with the male, one, two, three or four being put into the cage with him at the same time and left for two or three days.

Female.	Date of emergence.	Dates with the male.	Started to lay.	Batch of eggs laid.														Total number laid.	Numbers which hatched or developed to larvæ in respective batches.														Total number fertilized.	Percentage of fertile eggs.	Close of experiment.
				1	2	3	4	5	6	7	8	9	10	11	12	13	14		1	2	3	4	5	6	7	8	9	10	11	12	13	14			
I.	30 Oct.	1– 4 Nov.	7 Nov.	30	31	18	37	20	17	2	26	21	23	16	...	...	...	242	24	17	9	19	19	14	0	0	11	14	6	...	...	...	133	55	16 Dec.
II.	30 „	1– 4 „	11 „	4	...	...	...	...	...	...	...	...	...	...	...	...	...	4	0	...	...	...	...	...	...	...	...	...	...	...	...	...	0	...	19 Nov.
III.	30 „	1– 4 „	4 „	24	...	...	...	...	...	...	...	...	...	...	...	...	...	24	0	...	...	...	...	...	...	...	...	...	...	...	...	...	0	...	13 „
IV.	3 Nov.	4– 6 „	9 „	71	52	63	11	69	...	...	...	...	...	...	...	...	...	266	68	48	63	9	68	...	...	...	...	...	...	...	...	...	256	96	23 „
V.	3 „	4– 6 „	8 „	12	26	28	47	50	...	...	...	...	...	...	...	...	...	163	9	11	24	45	35	...	...	...	...	...	...	...	...	...	124	76	27 „
VI.	5 „	6– 8 „	15 „	7	...	...	...	...	...	...	...	...	...	...	...	...	...	7	0	...	...	...	...	...	...	...	...	...	...	...	...	...	0	...	17 „
VII.	5 „	6– 8 „	13 „	16	...	...	...	...	...	...	...	...	...	...	...	...	...	16	11	...	...	...	...	...	...	...	...	...	...	...	...	...	11	69	13 „
VIII.	5 „	6– 8 „	11 „	17	36	...	...	...	...	...	...	...	...	...	...	...	...	53	1	0	...	...	...	...	...	...	...	...	...	...	...	...	1	2	13 „
IX.	5 „	8–11 „	15 „	2	54	16	7	23	24	27	29	14	6	3	6	25	...	236	1	42	1	0	0	0	0	0	0	0	0	0	0	...	44	19	12 Jan.
X.	8 „	11–14 „	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	16 Nov.
XI.	8 „	11–14 „	14 Nov.	2	16	16	20	26	...	...	...	...	...	...	...	...	...	80	0	1	0	0	0	...	...	...	...	...	...	...	...	...	1	1	29 „
XII.	8 „	11–14 „	24 „	34	1	...	...	...	...	...	...	...	...	...	...	...	...	35	0	0	...	...	...	...	...	...	...	...	...	...	...	...	0	...	4 Dec.
XIII.	11 „	14–17 „	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	30 Nov.
XIV.	11 „	14–17 „	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	7 Dec.
XV.	11 „	14–17 „	10 Dec.	1	1	1	2	2	...	...	...	...	...	...	...	...	...	7	0	0	0	2	2	...	...	...	...	...	...	...	...	...	4	57	10 Jan.
XVI.	11 „	14–17 „	20 Nov.	24	...	...	...	...	...	...	...	...	...	...	...	...	...	24	0	...	...	...	...	...	...	...	...	...	...	...	...	...	0	...	21 Dec.
XVII.	12 „	17–20 „	21 „	1	...	...	...	...	...	...	...	...	...	...	...	...	...	1	0	...	...	...	...	...	...	...	...	...	...	...	...	...	0	...	22 Nov.
XVIII.	12 „	17–20 „	29 „	1	1	7	...	...	...	...	...	...	...	...	...	...	...	9	0	0	0	...	...	...	...	...	...	...	...	...	...	...	0	...	27 „
XIX.	15 „	20–22 „	3 Dec.	47	...	...	...	...	...	...	...	...	...	...	...	...	...	47	9	...	...	...	...	...	...	...	...	...	...	...	...	...	9	19	4 Dec.
XX.	17 „	20–22 „	25 Nov.	1	1	2	4	9	8	11	11	...	...	...	...	...	...	47	0	0	0	0	0	0	1	0	...	...	...	...	...	...	1	2	7 Jan.
XXI.	17 „	20–22 „	26 „	3	...	...	...	...	...	...	...	...	...	...	...	...	...	3	0	...	...	...	...	...	...	...	...	...	...	...	...	...	0	...	26 Nov.
														Total	...			1,264										Total	...				584 = 46 per cent.		

REMARKS.—I. to III., found dead; IV., disappeared, ? carried off by ants; V., escaped while feeding; VI. to XV., found dead; XVI., found dead, eggs abnormally small; XVII., disappeared, ? carried off by ants; XVIII. and XIX., found dead; XX., disappeared, ? carried off by ants; XXI., ants caught in act of devouring her.

Experiment No. XLVIII.

ENEMIES IN THE ADULT STAGE.

The most serious dangers to which adults of *Stegomyia fasciata* are exposed are probably those which arise from climatic causes. The daily rise of temperature, even in fine weather, is by no means excessive in Freetown, but it is sufficient to impart a considerable drying capacity to the air. During the dry season the dangers of desiccation are increased, while the incidence of the harmattan periods with strong, dry N.E. winds causes an enormous mortality among captive mosquitoes. Wild specimens, however, by seeking refuge either in crannies and crevices, or among moist vegetation out of doors or in dark recesses and corners within buildings, near floor level, away from any draught, can make local adjustment in their resting situations to minimize the danger. It is relative to this habit of seeking cover that the attacks of predaceous foes are most likely to occur, and, as a consequence, wingless enemies, such as toads, lizards, spiders, ants, scorpions and, possibly, also young mantids, probably take a heavier toll than do birds or flying insects, such as dragon flies; although the last named will almost certainly account for a certain number at the period when the mosquitoes leave the water and first take wing.

The habit which is so noticeable in resting *Stegomyia* of raising the third pair of legs and keeping them in constant motion, is probably a safeguard against attacks by wingless enemies, more especially ants. The elevation and movement of these legs will prevent their being easily seized hold of and they are available for an immediate kick-off, kangaroo fashion, at the slightest touch. When *S. fasciata* are deprived of their wings it at once becomes evident how considerable their leaping powers are. Two species of ants, *Monomorium pharaonis* L. and *Solenopsis geminata* F., proved themselves to be most inveterate enemies to captive mosquitoes during the progress of the research, and, as they appeared omnipresent in Freetown, mosquitoes are probably only safe from their attacks when actually flying.

In the mosquito house a small species of web-spinning spider, *Uloborus feniculatus*, and a larger species, belonging to the genus *Araneus*, which did not spin a regular web, took a heavy toll of the *S. fasciata* which were breeding in it. These spiders found entrance, when very small, through the 16 × 16 wire gauze and colonized it, breeding inside, using the corners and angles and covering the surface of the sides with their webs. The mosquitoes certainly formed their staple food, and, so far as observation of the captives in their webs went, were their sole source of supply.

Another uninvited guest in the mosquito house was a small species of scorpion, *Isometrus maculatus*, much flattened and with very slender claws. This must have found entrance through the crevice of a close-fitting, bevelled door when young, and possibly bred inside the house. From the slender, delicate structure of its pincers it is probable that it feeds on small insects only. A specimen kept in a 2-inch entomological glass-bottomed box was fed entirely on active adults of *S. fasciata*. It would capture and eat the entire number put into the box each night; sometimes disposing of 50 or 100 in a single night and, apart from its moulting periods, seems to have an insatiable appetite.

Small mantids in their first or second instars found their way into the mosquito house and were also found to capture and greedily devour specimens of *S. fasciata* when confined with them in a small box.

Two species of wall-hunting lizards were also tried; both were very young, considerably less than half grown. One, a species of *Lacertidæ*, probably *echinata*, cleared a large cage of *S. fasciata* with great despatch, but the other, a baby specimen of a gecko, probably *Hemidactylus brookii*, or one of its relations, only ate occasional specimens when they were placed in a small box with it, and made no appreciable difference to the numbers of mosquitoes in a large cage.

IV. PARASITES.

The larvæ and pupæ of *Stegomyia fasciata* reared in the mosquito house were found to be heavily infected with a species of gregarine, which has subsequently been identified by Dr. C. M. Wenyon as *Lancastriara culicus* Wenyon. This gregarine was found by Mr. A. C. Stevenson and Dr. C. M. Wenyon in specimens of *S. fasciata* reared from eggs laid upon leaves which were forwarded from Freetown for exhibition at one of the meetings of the Yellow Fever Commission.

The life cycle of this species has been thoroughly worked out by Wenyon (1911) in specimens of *S. fasciata* captured and bred at Bagdad, a fully illustrated account being published in "Parasitology," Vol. IV. 1911. From Stevenson and Wenyon's account of the gregarines in the specimens reared from the Freetown eggs and the experiments carried out by myself at Freetown, it is evident that the sporocysts are able to resist desiccation, and, like the eggs of the mosquitoes they infect, lie over the dry season in the dried-up water holes, awaiting ingestion by the larvæ which hatch out at the commencement of the rains. This habit of the parasite supports the view that *Stegomyia fasciata* relies chiefly, if not solely, upon the egg stage for the survival of the species during the dry period, as there would be no need for the sporocysts to have developed the ability to resist desiccation if the adult host survived the dry season in any numbers.

A trial carried out in order to test if infestation by the parasites had any checking influence on the development of the mosquito, or caused any mortality during larval life, showed no evidence of any ill effect on the development of the insect, nor was there any noticeable mortality in the larval stage. If any deaths at all occurred among the infected larvæ it was confined to the first or second instars.

The only other organisms detected in *S. fasciata* during the research were bacteria, which were present in small numbers in the larval gut and more plentiful in the stomachs of the adults, and some small oval bodies of from 2μ to 4μ in diameter, which were present in the stomachs of the adults. These were first noticed in smears of the dissected gut stained with Giemsa, and were suspected of belonging to the *microsporidia*, but sections failed to reveal any intracellular phases of the life cycle, nor could any undoubted evidence be obtained of their occurrence other than in the lumen of the gut. My colleague, Dr. H. M. Woodcock, of the Lister Institute, pronounced them to be yeasts.

V.—STERILITY OF THE PUPAL GUT OF THE *STEGOMYIA FASCIATA.*

In addition to the microscopic examination of the larval and pupal gut described on page 127, bacteriological tests were commenced in collaboration with Dr. G. G. Butler. Unfortunately, the trials had to be discontinued at an early stage of the investigation, owing to the calls of other duties on Dr. Butler's time.

A living pupa was allowed to swim for a few minutes in each of six tubes of sterilized distilled water—its transference from tube to tube being made with a sterilized platinum loop. The following tests were made in tubes of broth :—

	RESULT.
(*a*) An inoculation of water from the sixth tube ...	*Sterile.*
(*b*) The living pupa was allowed to swim in a tube of broth for five minutes	*Sterile.*
(*c*) The pupal gut with the malpighian tubes attached, was dissected out of the pupa and placed in a tube of broth	*Sterile.*
(*d*) The pupal envelope was placed in a tube of broth	*Sterile.*

Living pupæ were placed in a 1 per cent. lysol solution and allowed to swim about; they were all killed or rendered incapable of movement within fifteen minutes, but some became quiescent much sooner than others :—

	RESULT.
(*a*) A pupa was placed in 1 per cent. lysol for two minutes, its stomach was then dissected out and placed in a tube of broth...	*Sterile.*
(*b*) The malpighian tubes of the same pupa were placed in another tube of broth	*Sterile.*
(*c*) A pupa was placed in 1 per cent. lysol for five minutes, when it appeared to be dead ; it was then transferred to a tube of broth for fifteen minutes and then removed	*Sterile.*
(*d*) A pupa that had been in 1 per cent. lysol for two minutes was dissected and the gut, with its appendages, placed in broth	*Sterile.*

Living pupæ were placed in 1 per cent. lysol for two minutes and then washed in sterile water :—

	Result.
(*a*) The gut was dissected out of the imago, which was ready to emerge from one of these pupæ, and placed in a tube of broth	*Growth of unidentified bacilli.*
(*b*) The gut was dissected out of a pupa, in which the imaginal development was not so advanced, and placed in a tube of broth	*Sterile.*
(*c*) An entire undissected pupa was placed in a tube of broth	*Growth of unidentified bacilli.*
The gut was dissected, with the usual precaution of sterilized needles, slides and salt solution, from an unsterilized pupa, and placed in a tube of broth	*Sterile.*

It seems more probable that the pupal gut is sterile, and that the cases of infection were due to some mischance in the technique than that the infecting organism had persisted in the gut from the larval period. Such a conclusion is supported by the microscopical examination of other pupal guts already alluded to. (*See* Experiment No. XXVII.).

VI.—NOTES RELATING TO THE LIFE HISTORY OF SOME NEAR ALLIES OF *STEGOMYIA FASCIATA* AND ASSOCIATED SPECIES.

Stegomyia sugens.

Larvæ of this species were obtained solely from rock pools.

The development of the larvæ is very rapid under favourable conditions, rigorous selection, consequent upon the habit of breeding in the smallest of rock pools, probably having compressed the larval period into the shortest space consistent with physiological requirements. In captivity the eggs incubate within two days.

Eggs.—(Fig. 1, page 18). The eggs, although very similar to those of *S. fasciata* in general appearance, are smaller, shorter, and more oval in outline, with traces only of the flattening side which gives the egg of *S. fasciata* its asymmetrical aspect. The average size of six eggs was ·573 mm. in length and ·176 mm. in width, the smallest being ·530 mm. by ·176 mm. in width, the largest ·590 mm. by ·180 mm. The surface is covered with the same delicate cellular reticulation, central bosses not noticeably different from those on the eggs of *S. fasciata* being present. The wall surrounding the micropylar area was a trifle more prominent in the eggs compared, and had a slight outward slope or overhang.

As regards the power of hatching within a few minutes of immersion, serial hatching, resistance to drought and response to cooling the eggs are, so far as the smaller amount of experimental work entitles one to say, as well and similarly endowed as those of *S. fasciata.* (See experiment which follows).

Hatching of Eggs of Stegomyia sugens.—Two females reared from larvæ taken in a rock pool at Murray Town. Emerged on or about 18th October, placed in a large cage with males and afterwards kept in a small jar. One female died after the first batch was laid, the second on the 8th November.

Date on which eggs were laid.	Number of eggs laid.	Date of hatching.													
		October.		November.									December.		
		29	30	3	11	13	19	20	21	22	23	24	12	20	21
27 October	100	5	3	5	3	...	7	2	1	7	8	1	1	34	4
4 November	20	...	...	...	...	2	...	...	...	...	...	...	...	2	3

Notes.—A portion of the first batch of 100 were immersed at once, while about one-third were allowed to dry and immersed a week later. When these dried eggs were immersed 5 hatched within 15 minutes Subsequently both portions were treated alike.

The eggs were kept immersed from the 3rd to 11th November without any hatching; they were then transferred to fresh water 2° F. below that they were in. Three hatched during the night.

On the 17th November a portion of the eggs were dried, placed in an incubator at 98° F. for several hours and thence into a desiccator; on the following day they were placed in a moist atmosphere and after 24 hours drops of water were gradually added, until the filter paper on which they were laid was saturated. They were then submerged in shallow water. 7 emerged within 30 minutes.

A second portion was dried without the use of incubator or desiccator, but otherwise treated similarly. None of the eggs hatched within several hours of their immersion.

A third portion was kept immersed without any alteration of the conditions. None hatched. On the following day the pan containing these eggs was placed in an ice chest, and the temperature of the water lowered by 6° F. One larva emerged within an hour and a second within three hours.

On the following day the cooling was repeated without effect but two emerged the next day. Also 5 hatched of the batch that had been gradually wetted and immersed, after drying without the use of incubator or desiccator, three days previously.

On the 20th December, all the eggs having been kept in water since the 12th December, they were lifted from the water and exposed to the very dry wind then blowing. After half an hour they were re-immersed in the same water. 26 hatched within 15 minutes and 8 more within the hour.

These larvæ fed up rapidly and produced normal adults, which fed, paired and laid eggs in due course.

The remaining unhatched eggs were dried on the 31st December and stored on the ground in the mosquito house until April when they were re-immersed. None hatched, and on the 12th May the few remaining eggs that retained their shape were dissected and found to contain dead larvæ. These eggs, like the stored eggs of *S. fasciata*, suffered from the attacks of *Psocidæ*.

It is possible that the humid storage does not suit *S. sugens* eggs, which, judging by the situation of the breeding pools, must be

capable of withstanding great extremes of heat and drought. Dried eggs have hatched within 15 minutes of their immersion, and the larvæ have grown to full size within three days. Pupation has occurred within four-and-a-half to five days, and adults have emerged within six days of the hatching of the egg.

Probably under favourable conditions in the natural state the time would be shortened, in fact, the appended note shows that it may be, but the specimens in this case were undersized.

Breeding of Stegomyia sugens in Small Rock Pools.

On the 5th May a small basin-shaped rock pool on Tower Hill (Plate No. 5, page 9) was found to be swarming with larvæ of *Stegomyia sugens*. The pool, which was capable of holding about one litre, had a small amount of muddy sand at the bottom, and was fully exposed to the sun, situated on a large bare convex rock.

The larvæ were all of a size either already in their third skin or about to moult for the second time. As from its size and shape the pool did not seem capable of resisting more than two successive dry days, it was kept under observation. The following day was sunny, and by 5 p.m. more than half the water had evaporated. As a number of *S. sugens* were required in order to obtain eggs, about half the larvæ and water was taken. (Within a week 88 male and 72 female specimens of *S. sugens* had emerged, also 3 females of *S. fasciata* and 1 of *S. luteocephala* from the larvæ taken from this pool.) It threatened to rain the same night, but the tornado passed with only a few drops of rain. The next day being fine and sunny, the pool was dried and the sand at the bottom got a thorough baking, the shade temperature being 85° F. On the next night, the 8th, it rained steadily until daybreak and the pool was visited about 5.30 p.m., when it was found to contain numbers of young larvæ full grown in their first skins. There seems no doubt that these had hatched since the rain, as, apart from the baking which the pool had on the 7th, the fact that the larvæ were younger than those found in the pool earlier precludes any possibility of their being survivors of that brood. It is further certain that they must have hatched from resistant eggs lying in the hollow, as the interval between the commencement of the shower and the finding of the larvæ was not long enough to allow of the incubation of freshly laid eggs. On the evening of the 11th the water was again very low; development had, however, been extraordinarily rapid, a few of the larvæ having already pupated (within

three days of hatching), but they were distinctly small for the species. On the 12th the water had evaporated, but both larvæ and pupæ were found to be alive in the wet mud and became fully active in water. Heavy rain fell on the night of the 12th and saved the survivors from the fate of the earlier hatched members of the brood.

Adults.—No wild adults were obtained or seen. Experiments with bred specimens reveal it as an equally greedy and persistent feeder on human blood as its cogener *S. fasciata.* It, has, however, many traits which suggest it to be less domesticated than *S. fasciata*, which shows the laxness of pairing and feeding habits which so frequently occurs with animals brought into close relationship with man. Mating could only be obtained by the use of a large cage; it was not witnessed, and apparently only took place at night, while feeding during the daytime could only be induced by darkening the cage. Feeding was, however, quite dissociated from pairing, as virgin females kept in small boxes fed readily and repeatedly, sometimes to such excess that they voided the surplus blood, apparently quite undigested. Under these conditions small numbers of infertile eggs were laid, and the length of life of some of the specimens was over a month.

A subsequent trial with a larger number, including males, was made at the close of the rains, the insects being kept in a large cage because fertile eggs were not obtained when they were kept in small cages. In this case the length of life was shorter, there being a very heavy mortality within a few days of emergence. Not more than two batches of eggs were laid by segregated females, but this does not probably represent the limits of fecundity. Feeding would seem to be adjusted in relationship to egg laying, as with *S. fasciata*, taking place on successive nights, but being refused just prior to oviposition. No exact figures as to the number of eggs laid by a single female were obtained, but two females laid over 100 in a single night.

Stegomyia simpsoni.

Larvæ of this species were obtained from water holes in a cotton-wood tree, and a number were reared from a mass of leaves taken from the same holes during the dry season. A very general breeding place would, however, seem to be in small collections of water in the axils and whorls of leaves of the coco yam, cock hat tree, a species of *Dracæna* (*see* Plates 16 and 17, page 17), and banana.

Only infertile eggs were laid by captive females. (*See* Fig. 1, page 18.) These, while generally similar to those of *S. fasciata*

and *S. sugens* in colour, shape, size and surface structure, differ in several minor points. They are smaller and slightly more slender than those of *S. fasciata* and bilaterally symmetrical, while the micropylar wall is lower and less evident than that of *S. fasciata*. The measurement of two or three eggs gave the size as about ·550 mm. in length by ·120 mm. in thickness.

In the absence of fertile eggs laid by captive females it was not possible to follow up the larval life in detail, or carry out any experiments regarding the endowments of the eggs in respect of resting, serial hatching and response to external *stimuli*. That the eggs are drought-resisting, and that the species depends upon tiding over the dry season in the egg stage seemed obvious, but the record of rearing from leaves stored dry (see Notes on page 148) sets the fact beyond doubt. Time did not permit of searching the leaf axils of plants during the dry season for resting eggs. Failing their discovery in such situations, it remains to be proved whether the species uses these situations as auxiliary to water holes in trees, or if it can exist indefinitely when dependent upon leaf collections of water alone.

Adults.—The insects fed readily at night on human blood and to a limited extent in a darkened cage by day. They were individually almost, if not quite, as greedy as *S. sugens* or *S. fasciata*. As only infertile eggs were laid and these only at long intervals, though in fairly large batches, it is to be presumed that pairing did not take place in spite of the fact that various expedients were tried, and that a number of both sexes were kept together in a large cage. No attempts at pairing were witnessed. The length of life was not determined with any accuracy, but some of the females certainly lived for more than a month during September—October.

Stegomyia luteocephala.

This species was obtained in the larval stage chiefly from water holes in the roots of cottonwood trees, though a few were taken in rock pools of similar size to those affected by *S. sugens*.

Collections of water in tins or other utensils yielded larvæ at rare intervals, while a single specimen was reared from the coco yam.

Eggs.—(*See* Fig. 1, page 18). Infertile eggs approximate closely to those of *S. fasciata*, but are slightly smaller than the average eggs of this species. The girth is greater in relation to the length and the taper to the ends is consequently more marked, while the flattening of one side, which gives a slight asymmetrical outline to

S. fasciata from certain aspects, is accentuated. In the particular eggs compared there was a slight difference in the cellular reticulation, the walls in *S. luteocephala* appearing higher in relation to the central bosses, while the micropylar wall was lower. In the absence of fertile eggs no experimental work was carried out, but on the evidence obtained by rearing the species from a collection of dried leaves taken from a root hole it is possible to say that the eggs are undoubtedly endowed with similar drought-resisting powers to the other species of the genus already dealt with. On two or three occasions considerable batches of infertile eggs were laid by bred females on wet filter paper or wet wood (this latter seemed more attractive), but the majority of the females either died without ovipositing or laid only a few eggs at irregular intervals.

The larvæ, like those of *S. fasciata*, appear able to survive without water if kept moist. A larva was found among wet leaves in a small water hole ; its skin was already dry where exposed to the air, and it was incapable of movement. On immersion it recovered and a male specimen was reared.

Adults.—Like the other species of *Stegomyia* the females fed readily and vigorously on human blood, and were less disinclined to bite by day in a darkened cage than either *S. simpsoni* or *S. sugens*. Numerous attempts were made to induce the insects to pair, glass jars as well as small and large wooden cages being used. No attempts at pairing were observed, and it is to be presumed, as infertile eggs were laid on several occasions by the females, that copulation did not take place. The length of life was not accurately determined, but the females lived in captivity for several weeks.

Ochlerotatus apicoannulatus.

Specimens were reared from larvæ taken in water holes at the roots of trees, in rock pools and occasionally from water in tins. Many attempts were made to pair the insects and obtain eggs. Although the insects lived for two or three weeks in captivity, and the females bit fairly frequently, it was only occasionally that they filled themselves with human blood. In several instances, however, the same individuals fed several times. Towards the close of the dry season specimens were reared from a collection of fallen leaves taken from water holes at the roots of a cottonwood tree. These were placed in a large cage kept dark and moist by hanging wet clothing over it, and one or two of the females fed greedily by day on a human arm.

No attempts at pairing were observed and no eggs were laid.

Ochlerotatus minutus.

This species was reared from larvæ taken in numbers from rock pools, old tins and water holes at the roots of trees towards the close of the rains. Numerous attempts were made to get the insects to pair and oviposit, but they were unsuccessful. The females bit frequently, and sometimes fed well on human blood.

Uranotænia ornatus.

This species was reared from larvæ taken exclusively in the water which collects in the whorls and axils of the leaves of plants ; many attempts were made to feed, pair and obtain eggs, but they were all unsuccessful, and the insects never lived more than 36 hours in captivity. The females never attempted to take human blood or betrayed the slightest inclination to bite, nor were they observed to feed on the honey provided for them.

Eretmopodites.

Three species of this genus were taken in the larval stage; *E. quinquevittatus* from collections of water in tins, etc., in some numbers; *E. chrysogaster* sparingly from the same situations; and *E. draconis* commonly from collections of water in the whorls and axils of the leaves of various plants. The close similarity in general appearance and colouration of the species is very puzzling, and makes the segregation of active individuals for pairing purposes a matter of chance. The males of *E. chrysogaster* are easily determined by the tufts on their hind legs, but as regards *E. quinquevittatus* and *E. dracænæ* the only easy mode of determination is by an examination of the pupa. The females of *E. quinquevittatus* and *E. dracænæ*, and possibly those of *E. chrysogaster*, fed at irregular intervals on human blood until their stomachs were distended to an extent which greatly detracted from their elegant beauty. A number of specimens bred from a collection of larvæ were kept in H.L.C. cages and given nightly opportunities of feeding on human blood, honey being placed in the cages for the males. Occasionally they were all turned loose for a few nights into a large cage, the females being segregated afterwards for oviposition. Most of the specimens were *E. quinquevittatus*, but males at least of *E. chrysogaster* were also present. A small number of eggs were laid in twos and threes ; although there was no difference in colour or structure, there was a striking divergence in shape and size ; and as they

segregated into three sizes the eggs were reared in separate jars, but the pupal stage showed conclusively that all the eggs were all those of *E. quinquevittatus.*

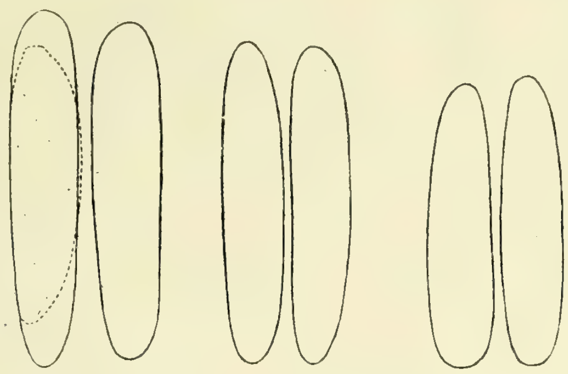


FIG. 3.

Outlines of eggs of *Eretmopodites quinquevittatus*, showing the wide variation in size which exists in the eggs of this species. Adults were reared from all the eggs. The dotted outline shows an egg of *Stegomyia fasciata* for comparison.

Both sexes were reared from the short eggs, and a pairing was watched in a H.L.C. cage ; the male came to the female while she was resting. The blood-sucking propensities of the bred specimens were as erratic as those of their parents, and biting was more frequent than actual feeding. Though the insects were hardy and bore confinement well, they did not live long—about three weeks being the average time, the longest life not being more than a month.

Eggs of E. quinquevittatus.—These were almost invariably laid horizontally, on the sides of the jar or on pieces of wood, just beneath the water surface, and the firmness of their attachment suggested the use of some cement. A small batch laid on the 12th October was divided, some of the eggs being dried and the others immersed in a pan of water. Those taken from the water all collapsed on drying while the others hatched. Unfortunately, no opportunity of repeating the experiment occurred, but the suggestion is that the eggs of this species are not drought resisting, and this is possibly supported by the fact that all the eggs previously laid hatched within a few days of laying, there being no cases of serial hatching or resistant eggs.

The eggs differ markedly in appearance from those of *Stegomyia*; they are bright brown in colour, the shell looking thinner and more

delicate. In shape they are longer and more cylindrical, with rounded rather than pointed ends, only the slightest trace of asymmetry being discernible at the micropylar end. The large eggs are nearly a third longer than those of normal *S. fasciata*, about ·8 to ·9 mm.; the medium sized about one quarter larger, about ·750 to ·780 mm., while the small eggs are scarcely, if at all, larger than normal eggs of *S. fasciata*—being about ·630 to ·650 mm. in length. These short eggs were, however, thicker than the medium sized ones, and relatively thicker than the long ones. Actually they were not quite so thick. The surface is smoother than that of the *Stegomyia* eggs, the cellular reticulation being more delicate, while the central area of the cells is slightly raised, or puffed, to use Mitchell's term. The appearance of the empty shell suggests, however, that the raised areas are structural features of the egg-shell, and not pockets containing a separate substance as in *Stegomyia*. In the absence of sections, however, it is not possible to speak with certainty on this point. All three forms of egg produced normal adults, the only observed differences being in regard to date of hatching and development of larvæ, the short eggs taking five or six days to hatch as against two or three in the case of the larger eggs; while the larvæ which emerged from them fed up more rapidly, but as the larvæ were kept in separate jars this may have been due to variation in food.

Larvæ.—The larvæ of these species are long, slender, even in comparison with those of *Stegomyia*, and of pale colouration. They show traits of ground feeding, moving over the sides and bottom of the jar with a walking or gliding movement, browsing as they go. This habit is also very noticeable with young larvæ of *Stegomyia fasciata*, but it gradually becomes less noticeable as they grow older, whereas it is characteristic of the larvæ of *Eretmopodites* when fully grown.

Pupæ.—In this stage *Eretmopodites* exhibit some marked divergencies from other mosquito pupæ, and also vary widely within the group. The abdomen is larger and longer in relation to the thorax and less curved, rendering the pupæ as a whole straighter and less "comma"-like than the other mosquito pupæ dealt with in this Report. The paddles are relatively small and heavily fringed with hairs, while in *E. quinquevittatus* the reduction in size is so marked, and the importance of the hairs on the apex of the paddles and terminal segments of the pupæ are so exaggerated, that it appears, superficially at any rate, to differ more from its fellow species within the group

than the genus as a whole does from *Stegomyia* in respect of pupal characters. (*See* Figures on pp. 142 and 144.)

Adults.—As already noted, these extremely beautiful and elegant insects are certainly blood suckers. It is, however, doubtful if man is the normal host. Specimens given honey and water and banama lived for two or three weeks, although they were never observed to feed on the foods given them. They have a characteristic habit of wandering about and carefully probing with their slightly curved proboscis the surface of wood and glass, as though searching for minute drops of moisture.

VII.—NOTES REGARDING THE POSSIBILITIES OF THE PUPAL PADDLES (ANAL PLATES OF WESCHÉ) FOR PURPOSES OF CLASSIFICATION AND THE SEPARATION OF ILL-DEFINED SPECIES.

An examination of the pupa cases of the species of *Stegomyia*, *Eretmopodites*, and other mosquitoes bred at Freetown during the course of the research, showed that very marked differences may occur in the pupal paddles of closely-related species. Though time did not permit of a full examination and detailed description being made of all the pupal characters, the divergence in shape and structure of these appendages* proved so convenient and easy a method of separating species closely resembling each other as do the females of *E. quinquevittatus* and *E. chrysogaster* that preparations and camera drawings were made of as many species as possible.

Incidentally this led to the discovery of a new species bred from collections of water in the central whorl and axils of the leaves of plants, which is described by Mr. F. W. Edwards under the name of *Eretmopodites dracænæ* Edw. in the "Bulletin of Entomological Research," Vol. VI., Part 4.

Although the divergence in structure between the paddles of *E. quinquevittatus* and those of the other species of the genus *Eretmopodites* is so remarkable, this would seem to be unusual, a slight difference, such as that existing between the various species of *Stegomyia* being more general; while, on the other hand, there may be a close approximation in character, as is the case with *Anopheles (Pyretophorus) costalis* and (*Myzomyia*) *funestus*. There seems, therefore, no likelihood, so far as the scanty material examined goes, that these characters could be made to afford the basis for an independent scheme of classification, such as has already been suggested on larval characters. On the other hand, these pupal appendages, which are obviously likely to be adaptive rather than ancestral in character, afforded so ready a means of discrimination in the above case that it seems worth while to call the attention of workers in this group of insects to their possibilities.

This appears to be the more necessary as Wesché (1910) in his paper dealing with the larval and pupal stages of the West African

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* Wesché (1910) terms these fins "Anal Plates." The authors of the Carnegie Monograph (1912, etc.) refer to them as "Anal Paddles."

Culicidæ has scarcely done justice to the pupal characters. The species he treats of do not show any such striking differences as those between the various *Eretmopodites* referred to above, but, judging by the plates illustrating his article, insufficient magnification has been used and the representation of *Anopheles (Pyretophorus) costalis* is seriously in error as regards the character of the terminal hair or seta on the paddle, which is really strongly reminiscent of a boot-hook. (Compare Fig. 19, page 146, with fig. 6, plate VI., in Wesché's paper.)

It is somewhat remarkable also that Messrs. Howard, Dyar and Knab (1912) in their monograph of the Mosquitoes of North and Central America and the West Indies have made but slight use of the pupal paddles, while to my great disappointment, the magnificent plates illustrating this work show the pupæ only in lateral aspect.

Pending the description and figuring of a wider range of species, the characters afforded by the paddles can only be used in the same limited manner as at first supplied to the genitalia of insects generally, *i.e.*, as a test of separation in difficult cases. For this purpose the paddles of mosquito pupæ are readily available, as the pupa case can be examined under a low magnification and the paddles are all in one plane.

Permanent mounts are very easily made. The empty pupa case should be removed from the breeding jar as soon after the emergence of the adult as possible ; while it still floats is best. It is then spread on a slide, the wing, leg and thoracic portions of the case being separated and opened out if desired. A cover slip is dropped over it and tied down with fine cotton ; it can then be dehydrated in alcohol, transferred to xylol to clear, the thread cut off and balsam run in without disturbing its arrangement.

All the figures are drawn to the scale of 30 diameters, except that of *Toxorhynchites brevipalpis*, which, owing to its large size, has only been magnified x 10.

In several cases the setæ, though represented as simple, are actually branched, but so minutely that it was impossible to show this feature without gross exaggeration. The marginal fringes to the paddles would appear in all cases to be the development of a serrated edge, even when the fringe is very long, as with *Eretmopodites chrysogaster ;* the distinction between these tapering filaments and the round sectioned setæ on the abdominal segments, or the terminal ones on the paddles, is quite clear. In some cases, as with *Stegomyia sugens* and

Ochlerotatus apicoannulatus, the serrations are excessively minute and delicate. In most instances it was only practical to represent these fringes by single lines.

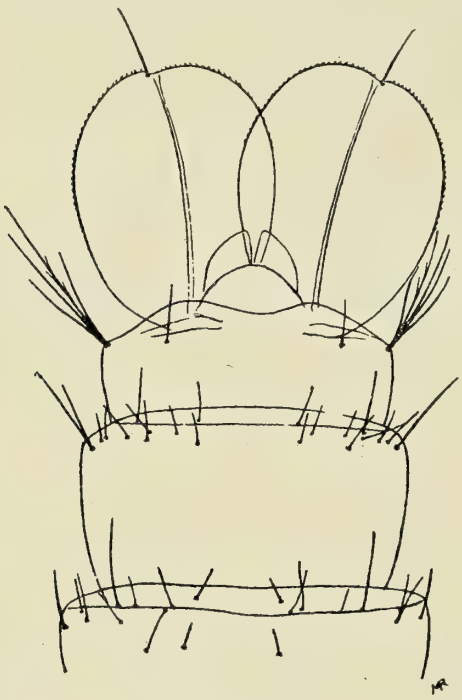

Fig. 4.

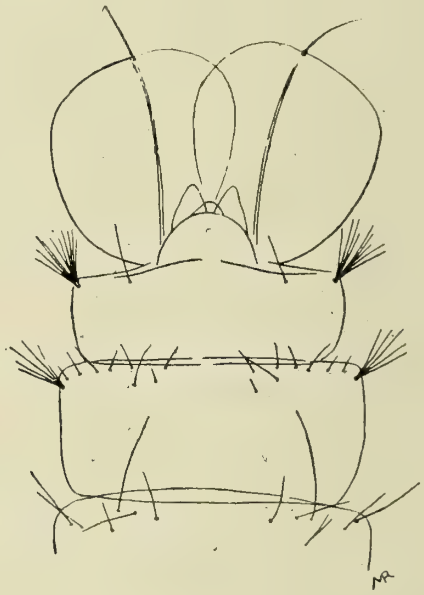

Fig. 5.

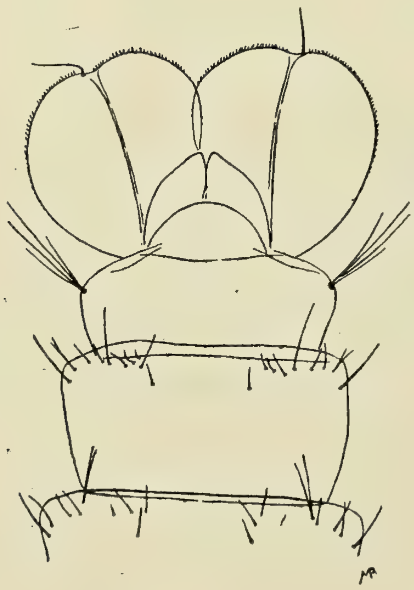

Fig. 6.

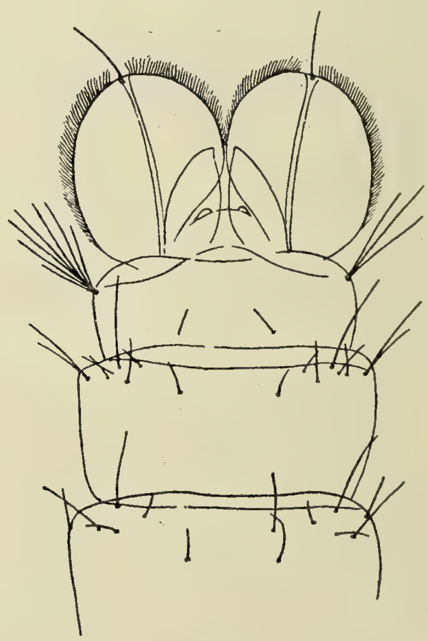

Fig. 7.

Figures 4, 5, 6 and 7 represent the paddles of *Stegomyia fasciata*, *sugens*, *simpsoni* and *luteocephala*. All four species show well marked differences, the marginal fringe in *fasciata* and *simpsoni* consists of delicate serrations. The asymmetry of the terminal lateral setæ on the eighth abdominal segment of *luteocephala* is rather noticeable, but is of course not a normal feature — asymmetrical divergence in the setæ of insects being by no means an uncommon phenomenon.

The paddles of *Ochlerotatus simulans* (Fig. 8), *apicoannulatus* (Fig. 9), and *minutus* (Fig. 10), though very similar in general appearance, each show one or more distinguishing features.

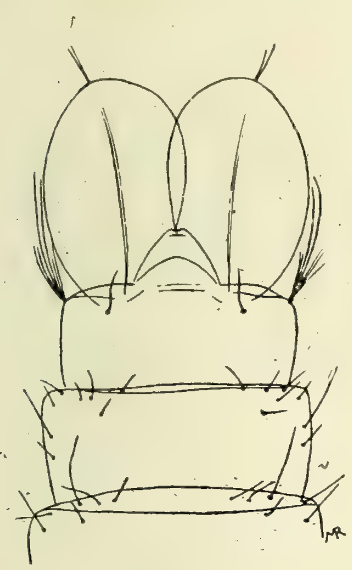

FIG. 8.

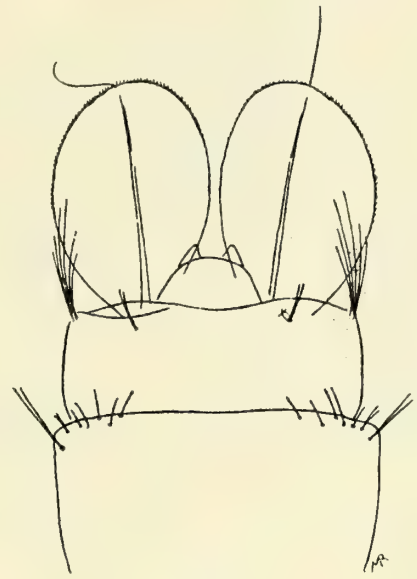

FIG. 9.

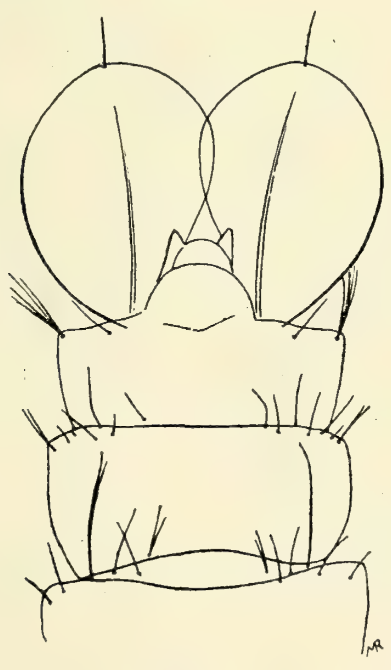

FIG. 10.

The four figures of the paddles of *Eretmopodites* are those of *quinquevittatus* (Fig. 11), *chrysogaster* (Fig. 12), *dracænæ* (Fig. 13), and an undetermined specimen (Fig. 14). The heavily fringed paddles of the last three specimens, together with the extraordinary specialization of *quinquevittatus*, make the group a very interesting one as regards this character. Only a single specimen of the undetermined species

was obtained, and, owing to some mischance, the adult which emerged from it either escaped or was mislaid, and a specimen of *E. dracænæ* was by mistake associated with it.

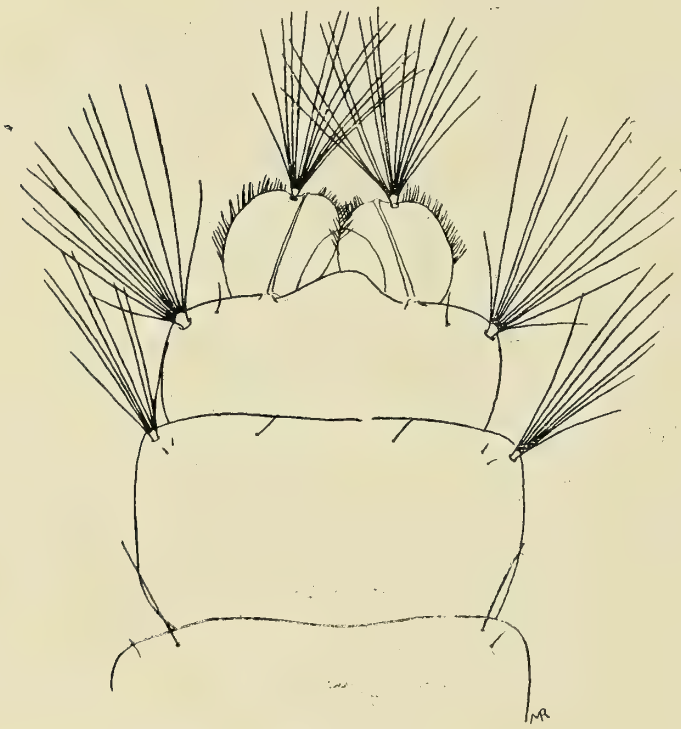

FIG. 11.

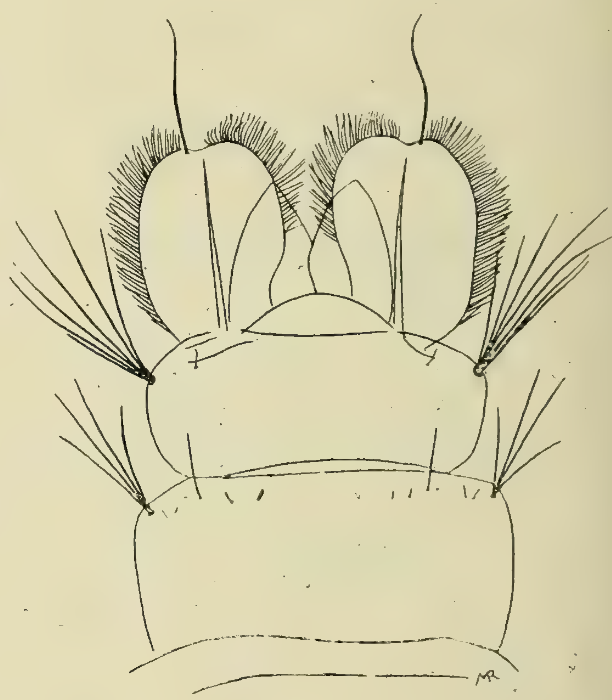

FIG. 12.

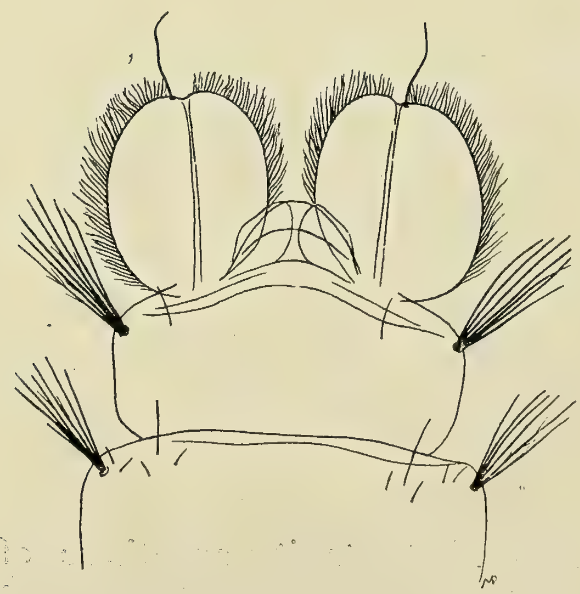

FIG. 13.

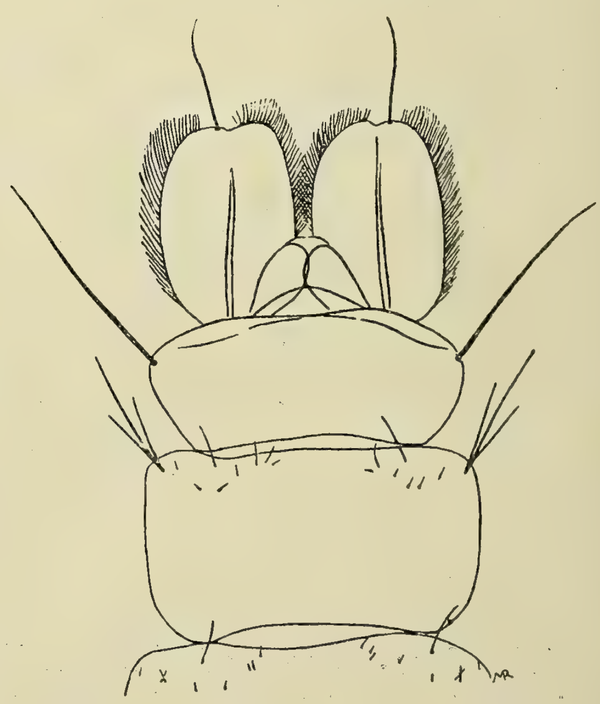

FIG. 14.

Uranotænia ornata (Fig. 15) was the only species of the genus taken; it has quite distinctive paddle characters.

Culex tigripes (Fig. 16) has broad fringeless paddles, with two small fan-branched lateral setæ on the eighth segment.

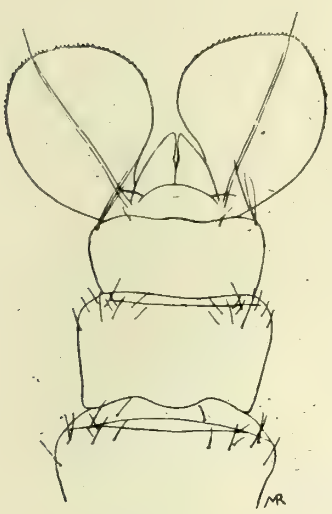

FIG. 15.

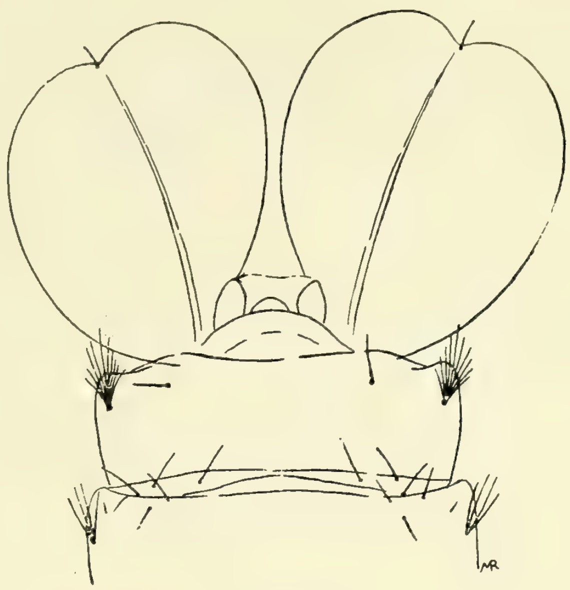

FIG. 16.

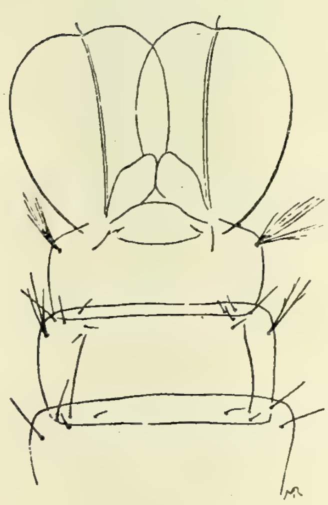

FIG. 17.

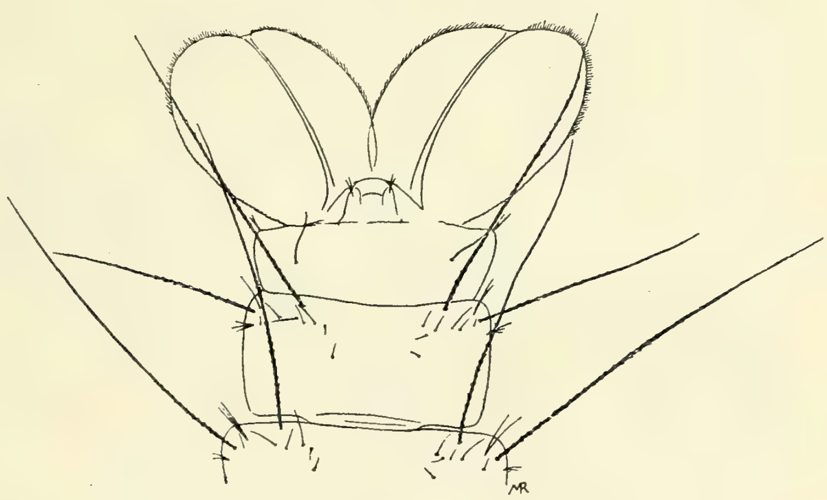

FIG. 18.

Culiciomyia nebulosa (Fig. 17) has much the same general type of paddles, but differs as regards these lateral setæ.

Toxorhynchites brevipalpis (Fig. 18).—The paddles of this giant species have no terminal spine; the lateral setæ on the eighth segment, which are specially developed on the other specimen figures, are small and inconspicuous, but certain dorsal setæ on the seventh and eighth abdominal segments are very long and markedly serrated.

Anopheles.—The only two species obtained were *Pyretophorus costalis* (Fig. 19) and *Myzomia funestus* (Fig. 20). They are almost identical in the character of the terminal segments and paddles, the only noticeable point of difference being that the lateral setæ on the eighth abdominal segment of *funestus* are larger, with less spread of the branches than in *costalis*. This difference is, however, rather more accentuated in the illustration than it should be.

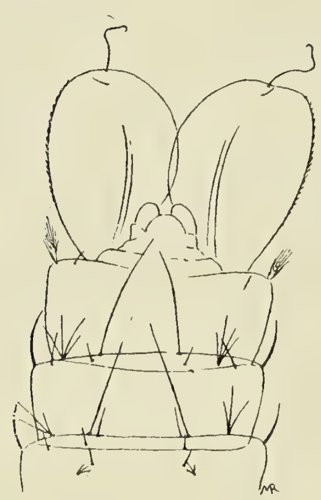

Fig. 19.

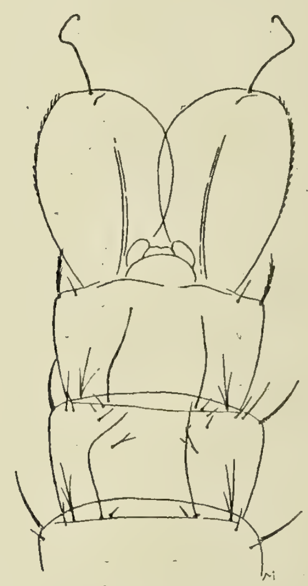

Fig. 20.

VIII.—NOTE REGARDING THE REARING OF SEVERAL SPECIES FROM DEAD LEAVES TAKEN FROM AN EMPTY WATER-HOLE DURING THE DRY SEASON.

In the early part of January a small number of fallen leaves in a dry water-hole at the root of a cottonwood tree were collected and examined for eggs (*see* Plates 1 and 2, p. 6). About thirty leaves were carefully examined under a binocular dissecting microscope. Eggs were found on several leaves; examples were sent home to be photographed by Mr. F. Noad Clark, and for exhibition at one of the meetings of the Yellow Fever Commission; these last were passed on to Mr. Malcolm Evan MacGregor, of the Wellcome Bureau of Scientific Research, who reared a number of specimens of *Stegomyia fasciata* from the eggs.* Specimens of *S. fasciata* were also reared in Freetown from eggs laid on one of the leaves.

PHOTOGRAPH OF EGGS OF *STEGOMYIA FASCIATA.*

Photo by F. Noad Clark.] *Plate No.* 23.

Eggs of *Stegomyia jasciata*, laid on a leaf of Cottonwood tree. × 40.

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* *Journal of Tropical Medicine and Hygiene.* "Notes on the rearing of *Stegomyia fasciata* in London," Vol. XVIII., No. 17, pp. 193–196.

During the latter part of January a further collection of fallen leaves was made from the dry water-holes* in the same tree, but, as time did not permit of their examination for eggs, they were left lying in a paper envelope on the laboratory bench. No opportunity for careful search having occurred by the 13th March, the leaves were placed in a new, carefully cleaned petroleum tin and about 5,000 cc. of tap water added. By the 15th March the water was swarming with larvæ of all sizes up to the third skin. A few were examined and found to be larvæ of *S. fasciata.* A number of dead cockroaches were placed in the tin on this date. On the 17th March (four days after the immersion of the leaves) about 30 pupæ were captured and transferred to glass jars. On the 18th a further 50 were caught in the tin ; 9 males of *S. fasciata* emerged from the first batch of pupæ one-hundred-and-twenty-six hours after the leaves were placed in water. On the 19th, 37 more males and 4 females of *S. fasciata* emerged ; over 100 specimens of both sexes emerged on the 20th March, and 1 male specimen of *S. simpsoni*; on the 21st March, in addition to *S. fasciata*, more specimens of *S. simpsoni* and a number of *S. luteocephala* and *Ochlerotatus apicoannulatus* emerged. There was rather a heavy death rate among the larvæ in the tin, due apparently to too large a number of cockroaches being added and causing a greasy scum.

The total numbers reared were :—

	S fasciata.		*S. simpsoni.*		*S. luteocephala.*		*O. apicoannulatus.*	
	Males.	Females.	Males.	Females.	Males.	Females.	Males.	Females.
March 18 ...	9	...	...	...	..	...	...	...
„ 19 ...	37	4	...	...	...	...	...	...
„ 20 ...	25	72	1	...	...	...	...	...
„ 21 ...	19	57	7	8	19	1	5	6
„ 22 ...	4	4	...	6	24	7	...	3
„ 23 ...	1	1	...	2	3	25	...	...
„ 24 ...	...	...	...	...	...	2	...	...
	95	138	8	16	46	35	5	9

* Although there was no water in the holes at this date, the matted mass of decaying leaves at the bottom was still moist ; these were not disturbed, only the loose undecayed leaves being collected.

From this record it will be seen that *S. fasciata* is easily the quickest breeder, the average times being: *S. fasciata*, 7·1 days; *S. simpsoni*, 8·4; *S. luteocephala*, 9·1; and *O. apicoannulatus*, 8·2. Perhaps the chief point of importance in this breeding record is the proof it affords of the passage through the dry season in the egg state of *S. simpsoni*, *S. luteocephala*, and *Ochlerotatus apicoannulatus*.

A careful watch was kept on the breeding tin for larvæ that were expected to emerge from resistant eggs, but none occurred, although cooling was resorted to. It is a possible, if not a very satisfactory, explanation that the grease in the water from the cockroaches proved fatal to the late hatched larvæ.

IX.—METEOROLOGICAL CONDITIONS AS AFFECTING THE BREEDING AND DISPERSAL OF MOSQUITOES AT FREETOWN.

The character of the incoming rainy season, together with the tornadoes which herald its approach, is probably of great importance in this connection, as quite small divergencies may cause exaggerated effects in regard to the numbers and distribution of the various species.

The early tornadoes (which commenced on the 7th March) were frequently of the nature of dry squalls; if accompanied by rain at all it usually fell only towards the end of the blow. Their direction was generally from the E.S.E., travelling down the estuary of the Sierra Leone River and through the gap in the hills behind Mount Aureol. They were generally accompanied by clouds of dust; and insects, especially small ones, such as mosquitoes, would easily be caught up and carried by the wind like snowflakes, dropping to earth behind any shelter, such as the banks of the brooks, houses and streets of Freetown would afford.

Coincident with these squalls reports of mosquitoes on the shipping in the harbour occurred, also cases of fever. Specimens of *P. costalis*, *S. fasciata* and a number of *C. nebulosa* were received from Dr. Costello of the s.s. "Transmitter," which lay some 500 or 600 yards off shore.

Some of the most extensive breeding grounds (Kissy flats, *see* Plates 13, 14 and 15, pp. 14, 16) for the *Anopheles* mosquitoes lay a few miles up river S.E. of Freetown, so that an immigration of these species into Freetown during the season of these dry squalls is a possibility to be reckoned with; more especially is this the case, as the squalls generally take place at night, or just before daybreak, when mosquitoes are likely to be on the wing.

It is therefore of importance to the mosquito section of the sanitation of Freetown that the administrative area should be enlarged so as to include these outlying districts, and attempts made to confine the surface water to definite cuts, in place of allowing it to trickle out over the large, gently-sloping areas bordering the railway (*see* Plates 9, 10 and 13, pp. 12, 13, 14).

It is also specially important that attacks on possible mosquito breeding places should be commenced at the very onset of the rains. These are necessarily few in number, and restricted in area at this period, and might be scheduled, as they will consist of pools in the

beds of the deeper drainage gullies (*see* Plates 24 and 25), and hollows, empty water-holes and small dried-up ponds. Later, when the rains are heavier and the showers more frequent, all these places will be impossible as breeding situations, because the drainage gullies (natural or artificial) will form the beds of streams so torrential in

ROCK POOLS NEAR WILBERFORCE STATION.

Plate No. 24.

Rock Pools in roadside drain. During early May these pools swarmed with pupæ of *Stegomyia*; in June and July the constant rainfall kept them washed clear.

character that any larvæ or pupæ will be swept into the creeks, while the larger and more permanent pools will have attracted numbers of frogs and toads intent on breeding. The available breeding places of the mosquitoes change as the season advances, the number of collections of water being enormously increased, as even the slightest

hollows can be utilized when showers are constantly renewing the water in them (*see* Plates 4, 5 and 7, pp. 8, 9, 11). Very great risks of drying up are taken by the species, as the notes on *Stegomyia sugens* on page 132 will show, but mosquitoes, and especially *Stegomyia*, with its serial hatching eggs, are adapted to these precarious conditions;

MOSQUITO BREEDING POOL.

Plate No. 25.

Rock Pool in the gutter of Murray Town Road, which was tenanted by swarms of pupæ of *Stegomyia sugens*.

the constant dangers from predaceous enemies and competition by other organisms, whose life cycle is not so rapid, in the more permanent collections of water being of more moment to the species than the mortality arising from climatic conditions.

X.—EXPERIMENTS DEALING WITH THE DESTRUCTION OF *STEGOMYIA FASCIATA.*

Experiments dealing with the destruction of *Stegomyia fasciata* were limited to the egg, larval and pupal stages, and the use of simple and easily obtained articles—ordinary burning petroleum, soft soap, flake naphthalene and salt water (from the harbour)—one of the objects of the trials being to ascertain to what extent the eggs were destroyed by methods readily applicable to the larval stage. The tests carried out with emulsions were directed chiefly against the active larval and pupal stages, the attenuated quantities of emulsions used having but little effect on the resistant eggs.

No experiments were conducted with the adult insects, as with the limited time and means at my disposal the possibility of improving on the already recorded remedies and tested methods of applying them seemed remote.

In order to render the tests as strictly comparative as possible, the trials with the different substances were carried out at the same time, the eggs, larvæ or pupæ being taken from a common source, the test on eggs with petroleum-soft soap emulsion being an exception.

Experiment No. XLIX.

COMPARATIVE EFFECT OF SOFT SOAP AND PETROLEUM (1 IN 600) ON EGGS, LARVÆ AND PUPÆ.

300 cc. of tap water was placed into each of two large beakers of three-and-a-half inches diameter.

A portion of a large batch of eggs of *Stegomyia fasciata* recently laid on filter paper was then submerged in each of the beakers, and a number of active, well-grown larvæ and pupæ were also put in.

·5 cc. of petroleum (= 1 in 600) was dropped on the surface of the water in beaker *P.*, while ·5 gram of soft soap (= 1 in 600) was dropped into beaker *S.S.*

50 eggs of the same batch were placed in salt (harbour) water as a control.

Temperature of water about 80° F.

Within 1 *hour* most of the larvæ and pupæ were dead in both of the beakers.

After 20 *hours.*

Effect on eggs :—

P.—Some of the eggs have hatched and the young larvæ are swimming about.

S.S.—No young living larvæ are visible.

Salt Water Control.—A number of eggs have hatched and the young larvæ are dead.

The eggs were then removed from the water and halved, one-half being returned to the beakers and the other carefully examined under the binocular microscope :—

P.—4 eggs had hatched out of 61 examined.

S.S.—No eggs had hatched out of 68 examined.

These half batches were then dried and put into clean tap water to test the effect of 20 hours' immersion in petroleum and soft soap on them.

After 48 *hours' immersion.*

P.—Many more eggs have hatched and larvæ are living ; at least one has moulted.

Of the half removed to tap water, 28 have hatched and larvæ are living.

S.S.—Of the eggs left in the beaker, 31 out of 60 have hatched, but no living larvæ are visible, the water is too cloudy to admit of certainty as to all being dead. Of the half removed to tap water 39 have hatched, all of which are living.

Salt Water Control.—31 out of about 50 eggs put in have hatched; only one larva is living (it died shortly afterwards).

After 96 *hours.*

P.—The water still smells of petroleum, but the larvæ which hatched from the eggs are doing well.

S.S.—No signs of living larvæ.

Of the eggs removed from the beakers after 20 hours' immersion in water to which petroleum or soft soap had been added, all but two or three doubtfully fertile eggs have hatched.

In the salt water control 8 more larvæ have hatched and the larvæ are dead.

After 8 *days.*

P.—A large number of small, underfed but active larvæ are present. All the eggs have hatched.

S.S.—No living larvæ. All the dead ones found are in the first skin. A few unhatched eggs present. After drying and re-immersing these resistant eggs in clean water 13 hatched within two days, but about half the larvæ died shortly after emerging.

Conclusion.

Petroleum.—1 in 600 kills all larvæ and pupæ but fails to destroy the eggs, and the larvæ which hatch survive.

Soft Soap.—1 in 600 kills all larvæ and pupæ and also the young larvæ which hatch out from submerged eggs. It has no effect on eggs which have been submerged for 20 hours, but has detrimental effects on a proportion of those which have been submerged for 8 days.

Experiment No. L.

Second Trial.

CONTRASTED EFFECT OF PETROLEUM (1 IN 4,000), SOFT SOAP (1 IN 8,000), AND NAPHTHALENE (1 IN 8,000) ON EGGS, LARVÆ AND PUPÆ OF *STEGOMYIA FASCIATA.*

In this experiment thoroughly cleaned petroleum tins cut down to six inches in depth were used. The size of the tins is nine inches by nine inches with curved corners. Approximate surface area, 80 square inches.

4,000 cc. of tap water was poured into each tin and a portion of a large batch of eggs, laid three months previously on filter paper and stored dry, was submerged in the water. A number of active larvæ and pupæ from the breeding pans were also added.

P.—1 cc. of petroleum was dropped on the water in one tin.

S.S.—·5 gram of soft soap was dropped into another.

N.—·5 gram of flake naphthalene was scattered on the water of the third.

All the pans were covered with cheese cloth. Temperature of water about 80° F.

After 24 *hours.*

P.—11 adults have emerged and are living. The larger proportion of the larvæ and pupæ are dead, but a number are still living.

Eggs.—Large numbers of eggs have hatched; some of the young larvæ are dead but the great majority are active.

S.S.—15 adults have emerged and are living. Most of the pupæ and larvæ are still active but a few are dead.

Eggs.—Swarms of newly-hatched larvæ are swimming about. No dead observed.

N.—The pupæ seem to be quite unaffected, but all the adults that have emerged are dead. All the larvæ, save a few inactive, sickly-looking ones, are dead.

Eggs.—Numbers have hatched but there are no newly-hatched living larvæ to be seen.

The larvæ which hatched out in *P.* beaker of the first test (1 in 600) (Experiment No. XLIX.) and lived for eight days were put into *N.* pan of this series.

After 48 *hours.*

P.—10 more adults out. All the remaining pupæ and most of the active larvæ which were put in are dead.

Eggs.—The larvæ which have hatched out are now very numerous. A small proportion are dead, but most are quite active and many are in their second skins.

S.S.—9 more adults out. The greater number of the larvæ put in and a few pupæ are still living.

Eggs.—Swarms of active newly-hatched larvæ are visible.

N.—The flakes of naphthalene have now largely disappeared from the surface of the water; some have sunk, others have doubtless evaporated.

21 more adults are out—11 dead, 10 living. Only 3 living larvæ, of those originally put in and those transferred from the *P.* beakers in the first trial, remain.

Eggs.—Large numbers of dead newly-hatched larvæ are visible but no living ones.

Conclusion at 48 Hours.

Petroleum.—1 in 4,000 (1 cc. to 80 square inches area), while generally effective as a larvicide, allowed of a few survivors. It is very ineffective as against pupæ, a considerable proportion being able to complete their development and successfully emerge as adults. Its effect on submerged eggs or the larvæ hatching from them is negligible.

Soft Soap.—1 in 8,000 is practically useless. It kills only a small proportion of the active larvæ and pupæ and has no effect on the eggs or young larvæ that emerge from them.

Naphthalene.—1 in 8,000 is not effective as against pupæ, but (in a covered pan) kills all adults that emerged within 24 hours and about 50 per cent. of those emerging on the second day. With a few exceptions it is fatal to all larvæ, those emerging from eggs as well as those present from the start, for a period of 48 hours.

Experiment No. LI.

Sequel to Experiment No. L.

After 8 days.

P.—The few resistant larvæ of those put in continued to live, while the young larvæ that hatched from the eggs grew and thrived so far as a rather short allowance of food would allow them.

·5 gram of flake naphthalene was sprinkled over the surface of the water and the cheese cloth cover removed. Within 24 hours the great majority were either dead or dying.

A few survivors were still living after 48 hours, when a further gram of flake naphthalene was sprinkled on the water, the pan remaining uncovered.

Although the numbers living when this additional quantity of naphthalene was added were reduced a few of the larvæ survived and pupated.

S.S.—Upon the conclusion of the 48 hours' test there were a considerable number of pupæ and well grown larvæ present in addition to the swarms of young ones that had emerged from the eggs. Food (dead grasshoppers) was

placed in the tin and another ·5 gram of soft soap added, bringing soap content up to 1 in 4,000. This addition had no apparent effect in reducing the numbers after 48 hours; the young larvæ had grown and some of the older ones had pupated.

The addition of another gram brought the soap content up to 1 in 2,000. 72 hours later observation showed that the increase was partially effectual. Adults emerged from the pupæ and some of the better grown larvæ were still active, but the great proportion of the young larvæ were dead, although a few which had reached the third skin survived.

A third gram of soft soap was added (3 in 4,000). This also proved after 48 hours to be only partially effectual, living larvæ and pupæ being still present. 24 hours after the addition of a fourth gram (1 in 1,000 strength) all the survivors were dead. A fresh batch of larvæ and pupæ were added, and these also were all killed within 24 hours.

Of a further batch which were placed in the pan some survived until the second day, but all were dead after 72 hours.

Naphthalene.—In addition to the trial with the surviving larvæ of *P.*, in Experiment No. L., as above recounted, a few of the older larvæ which had survived the 48 hours' trial at 1 in 8,000 naphthalene were living, together with a number of young ones which had hatched out a day or two later when the effects of the naphthalene had passed off. A gram of naphthalene was sprinkled on the surface of the water to try the effect of 1 in 4,000 without the cover to the pan; most of the young larvæ were quickly killed off, but a few survived.

With a covered pan 1 in 4,000, however, proved effective, all the larvæ and pupæ or the adults emerging from them being killed.

Conclusion arising from the Sequel.

Soft Soap.—At less strength than 1 in a 1,000 soft soap is not an effective larvicide, but at this concentration it is decidedly superior to petroleum and is more lasting in its effects. Its effectiveness, however, gradually ebbs.

Naphthalene.—At 1 in 4,000 (1 gram to 80 square inches) kills all larvæ and pupæ or the adults emerging from pupæ in a pan with a cheese cloth cover. It is not, however, totally effective if the cover is removed.

Experiment No. LII.

Third Trial.

EFFECTIVENESS OF PETROLEUM AND SOFT SOAP, AND PETROLEUM, SOFT SOAP AND NAPHTHALENE IN EMULSIFIED FORM AS COMPARED WITH PETROLEUM ALONE TO DESTROY LARVÆ AND PUPÆ.

The emulsions used were constituted as follows:—*Petroleum and soft soap.* 3 parts soft soap melted by heat in 15 parts of water; 100 parts of petroleum added very gradually with much stirring and shaking while the soft soap was still hot.

Petroleum, Soft Soap and Naphthalene.—4 parts soft soap melted in 20 parts of water. 15 grams of naphthalene was gradually added to 100 cc. of petroleum (this appears to be the saturation limit at 80° F.). The petroleum with the naphthalene in solution was then added very gradually, with much stirring and shaking, to the hot soft soap solution.

In practice it was found best to dilute the small quantities of emulsions used with a little water before adding it to the pans which contained the larvæ and pupæ.

Tests.—These were conducted in cleaned empty petroleum tins cut down to six inches in depth; the surface area was approximately 80 square inches and the water contents 4,000 cc. Tins with cheese cloth covers.

Period 20 *hours.*

(1) *Petroleum.*—1 in 4,000 killed 7 pupæ and 37 larvæ. 1 pupa survived and an adult emerged but died.

P. S.S. emulsion.—1 in 8,000 killed all, 11 pupæ and 31 larvæ.

P., N. and S.S. emulsion.—1 in 8,000 killed all, 14 pupæ and 47 larvæ.

(2) *Petroleum.*—1 in 8,000.

After 20 hours 3 adults emerged and died, 5 pupæ and 3 larvæ living, 40 larvæ dead.

After 48 hours 3 more adults emerged, 1 living, 2 dead; 1 pupa living, 1 pupa and 3 larvæ dead.

P. S.S. emulsion.—1 in 16,000.

After 20 hours 1 adult emerged and died; 8 pupæ dead; 62 larvæ dead; 1 larva just capable of movement, but unable to leave the surface; was dead next morning.

P., N. and S.S. emulsion.– 1 in 16,000.

After 20 hours 10 pupæ dead; 36 larvæ dead; 1 larva just capable of movement, but unable to leave the surface; was dead next morning.

(3) *P. S.S. emulsion.*—1 in 20,000.

After 20 hours 23 pupæ dead; 27 larvæ dead; 3 pupæ and 5 larvæ swim freely; 2 larvæ make feeble movement, but cannot leave the surface.

After 40 hours 5 pupæ and 1 larva survive and are active.

P., N. and S.S. emulsion.—1 in 20,000.

After 20 hours 3 adults emerged and died; 20 pupæ and 29 larvæ dead; 1 pupa living; 4 larvæ make feeble movement, but cannot leave the surface.

After 40 hours all the survivors dead.

A second trial with *P., N. and S.S.* at 1 in 8,000 killed all the larvæ and pupæ put in the same day, and rendered a second batch put into the same tin on the following day incapable of active movement within one hour, but two or three of this second batch of larvæ survived until the next day.

Conclusion.

Petroleum, soft soap and naphthalene when blended together in emulsified form are much more effective and economical in use than when used separately.

P. and S.S. emulsion killed all at 1 in 16,000 and a large proportion at 1 in 20,000.

P., N. and S.S. emulsion killed all at 1 in 20,000.

Experiment No. LIII.

EFFECT OF PETROLEUM AND SOFT SOAP EMULSION ON THE EGGS OF *STEGOMYIA FASCIATA.*

This test was not carried out at the same time as the larval and pupal trials, but several months later.

Petroleum and soft soap emulsion used, 1 in 8,000 dilution.

Eggs laid not more than three weeks and dried about a week previously.

After 22 hours.

144 out of 156 eggs had hatched (= 92 per cent.), 2 larvæ showed feeble movement, and the rest were dead.

12 unhatched eggs transferred to tap water.

Transferred Eggs.—6 hatched next day, the larvæ lived.
Remaining eggs opened on the ninth day.
3 living larvæ and 2 dead ones extracted.
Remaining egg infertile.

Control.—A portion of the same batch of eggs, 196 in number, was placed in tap water.

81 hatched (= 41 per cent.), 1 larva died.

Recently-laid eggs that had been kept moist were also tested in a separate pan :—

36 out of 42 hatched in 22 hours (= 85 per cent.) and died.
6 unhatched eggs were transferred to tap water.
All 6 of the transferred eggs hatched next day ; the larvæ lived.

A batch of eggs that had been stored dry for 4 months was submerged in the same diluted emulsion, 1 in 8,000.

Out of 51 eggs, some of which showed signs of shrinkage, 6 hatched within 22 hours and 2 uncapped, but the still living larvæ had not emerged at the time of observation. The remaining eggs were removed to tap water. The larvæ which emerged in the emulsion all died.

After transference to Tap Water.

Next day 6 eggs uncapped :—2 larvæ out, making feeble movements.
2 ,, ,, , dead.
2 larvæ failed to get free of shells.

2nd day	2	hatched :—	1 dead,	1 living.
3rd ,,	5	,,	3 ,,	2 ,,
4th ,,	5	,,	4 ,,	1 ,,
5th ,,	4	,,	1 ,,	3 ,,
6th ,,	4	,,	All dead.	

On the 9th day the unhatched eggs were opened. 1 living larva was extracted; all the other eggs contained either dead larvæ or were infertile.

Conclusion.

Submergence in petroleum-soft soap emulsion (1 in 8,000) is not effective in killing larvæ within the eggs, though it is possibly the cause of some mortality. It is, however, effective in that it induces a high percentage of the less resistant eggs to hatch at once, when the young larvæ are killed.

XI.—EFFECT OF SALT WATER (FROM FREETOWN HARBOUR) ON THE EGGS, LARVÆ AND PUPÆ OF *STEGOMYIA FASCIATA.*

In their conception these experiments were complementary to those performed by Macfie (1913–14) with common salt ("A Note on the action of Common Salt Water on the Larvæ *Stegomyia fasciata*," "Bulletin of Entomological Research," Vol. IV., Pt. 4, pages 339–344, by Dr. J. W. Scott Macfie, M.A., M.B., Ch.B., West African Medical Staff), their purpose being to test the effect of salt water on the eggs, a point Dr. Macfie did not deal with.

Experiment No. LIV.

EFFECT ON EGGS, LARVÆ AND PUPÆ CONTRASTED.

Preliminary.—A large batch of several hundred eggs laid two months previously was divided; half were put into water taken from the harbour and half into tap water.

A number of active larvæ and pupæ from the breeding pans were also put into the salt water. Temperature 80° F.

The first eggs to hatch were some of those in the salt water (within 15 minutes of immersion), those in the tap water commenced a few minutes later. None of the larvæ which hatched from the eggs placed in salt water survived more than an hour.

After 16 hours.—All the active larvæ placed in the salt water were dead. From the pupæ many adults had emerged and were living; the remaining pupæ were all living and successfully completed their development.

Eggs.—Two or three hundred had hatched, the number of larvæ which had emerged being larger in the salt than in the tap water. In the salt water all were dead, in the tap water all were living. After 48 hours a careful examination showed that of the eggs placed in salt water all had hatched save a few, which subsequent dissection showed contained dead larvæ.

Of the portion of the batch of eggs placed in tap water many were unhatched. Larvæ continued to hatch from the eggs at intervals.

Experiment No. LV.

TRIALS WITH EGGS ONLY.

Salt water from the harbour was filtered and 170 cc. placed into each of two beakers, *D* and *M*.

Controls.—170 cc. of tap water was placed in each of two beakers *Dc.* and *Mc.*

Eggs dry; laid on filter paper a month previously and stored dry. The slip of paper was divided and one portion with 102 eggs on it placed in *D.*, the other, with 106 eggs on it, placed in *Dc.*

Eggs kept moist; laid a month previously and stored under conditions which kept the filter paper on which they were laid moist.

The slip of paper was divided, a portion with 107 eggs on it was placed in *M* and the other with 95 on it was placed in *Mc.*

D. 102 dry.—After 2 hours' immersion 3 had hatched; larvæ dead.
,, 22 ,, ,, 89 ,, ,, ; ,, ,,

Microscopic examination showed that 95 eggs had uncapped, but 2 larvæ died without emerging. Of the 7 remaining eggs 2 collapsed on drying, 5 retained their shape. These 5 eggs resisted continued immersion in tap water for 20 days, during which period they were subjected to "cooling" on five occasions. Dissection showed that 4 of the eggs contained fully developed larvæ, 2 of which were living, 1 showed no movement and 1 showed signs of decay.

Total hatched, 89 = 87 per cent.

Dc. Tap water control.—106 eggs (a portion of the dry batch used in *D*).
After 2 hours' immersion 33 had hatched and were living.
,, 22 ,, ,, 1 ,, ,, ,, ,, ,,

Microscopic examination showed that 34 eggs had uncapped. Of the 72 remaining eggs 2 had collapsed while immersed and 2 more collapsed on drying. 68 were re-immersed in tap water.

After 1 day	... ...	2 hatched.
,, 3 days	... ...	1 ,,
,, 4 ,,	... ...	1 ,,
,, 8 ,,	... ...	4 ,,
,, 9 ,,	... ...	11 ,,
,, 10 ,,	... ...	18 ,,
,, 11 ,,	... ...	4 ,,
,, 16 ,,	... ...	3 ,,
,, 18 ,,	... ...	2 ,,
		46

50 per cent. of salt water was then added to the tap water in the pan.
The same day 1 hatched larva lived.
After 6 days 2 ,, larvæ ,,
,, 18 ,, 3 ,, ,, ,,

All the remaining eggs were dissected and 5 living larvæ were extracted, the remaining 11 eggs contained dead larvæ or were infertile. Total hatched, 81 per cent.

M. 107 *Moist.*—After 2 hours' immersion 49 had hatched—all dead.
,, 22 ,, ,, 46 ,, ,, ,,

Microscopic examination showed that 98 had uncapped; 3 larvæ had died without emerging. 5 eggs had collapsed while in the water. 1 collapsed on drying. 3 retained their shape.

These 4 eggs were then immersed in tap water.

After 1 day 1 hatched, and the larva lived.
,, 9 days 1 ,, ,, ,, ,, ,,
,, 10 ,, 1 ,, ,, ,, ,, ,,

Dissection showed that the collapsed egg was infertile. Total hatched, 98 = 92 per cent.

Mc. Tap water Control.—95 eggs (a portion of the moist batch used in *M*).

After 2 hours' immersion 25 had hatched living.
,, 22 ,, ,, 2 ,, ,, ,,

Microscopic examination showed that 27 had uncapped, 8 eggs had collapsed while in water, 2 collapsed on drying, 58 retained their shape and were re-immersed in tap water.

After 1 day...	... ...	2 hatched living.
,, 8 days	... ...	3 ,, ,,
,, 9 ,,	... ...	2 ,, ,,
,, 16 ,,	... ...	5 ,, ,,
,, 17 ,,	... ...	2 ,, ,,
		14

100 per cent. of salt water was then added to the tap water in the pan.

The same day 1 hatched and died.
After 11 days 1 ,, ,, ,,
,, 12 ,, 11 ,, ,, ,,

All the remaining eggs were dissected and found to contain dead larvæ or in a few instances were infertile. Total hatched, 54 = 57 per cent.

All the eggs were cooled on the 7th, 8th, 9th, 15th and 17th days after immersion.

Experiment No. LVI.

TRIALS WITH SPECIALLY RESISTANT EGGS

A large batch of eggs, which had been laid on filter paper and stored dry for two months, was immersed in tap water for five days. During this period several hundreds hatched. From among the resistant unhatched eggs two lots, each of 100 full eggs, were picked out with a wet camel hair brush and placed on wet filter paper. The slips of filter paper were allowed to dry and the collapsed eggs were removed, one of the slips was caught up by a draught during this operation and a number of eggs were lost.

There remained 65 full eggs on the one paper and 91 on the other.

The slip with 91 eggs on it was submerged in salt water, *S.W.* That with 65 eggs on it was placed in tap water as a control.

S.W.—After 20 hours 33 had hatched and died.

Tap Control.—After 20 hours 1 had hatched and was living.

After 44 hours' immersion no more larvæ had hatched. The slip was removed from the salt water and placed in tap water.

The record of the two lots is as under :—

RECORD OF THE EGGS AFTER REMOVAL FROM SALT WATER ON THE 4TH APRIL.

Lot.	Date of hatching.																
	April.														May.		
	* 10	* 11	12	* 13	14	15	16	* 18	19	* 20	* 23	* 25	28	30	4	10	12
S.W. ... ... (In tap water after 44 hours' immersion in salt water.)	3	1	31	...	...	...	...	...	...	...	...	...	1	...	1	1	1
Tap Water Control ...	6	6	...	18	1	2	2	3	2	3	4	7	...	2	1	...	1

On the dates marked with an asterisk the pans were cooled in an ice chest. During May the pans were placed out of doors at night; the 3rd and 9th were cool nights.

The larvæ of the *S.W.* lot which hatched out on the 4th and 10th of May died after emerging.

On the 13th May the remaining unhatched eggs were dissected. 9 living larvæ were extracted from the *S.W.* lot and 5 living larvæ from the control lot. The remaining eggs contained dead larvæ or were infertile.

SUMMARY OF RESULT.

Of 91 full resistant eggs 33 (=36 per cent.) hatched in response to 20 hours' immersion in salt water (Harbour water), while only 1 (=2 per cent.) of the 65 similar control eggs placed in tap water hatched during the same period.

Subsequently, of the balance of the 91 eggs, on removal after 44 hours' immersion in salt water to tap water, 39 (=43 per cent.), hatched, all but two of the larvæ living, and 9 living larvæ were extracted from the eggs 39 days after their removal from salt water.

Mortality, 10 = 11 per cent.

Of the control eggs, 1 only had hatched during the first 44 hours' immersion. Subsequently, 58 (= 89 per cent.), hatched over a period of 39 days mainly in response to cooling, and 5 living larvæ were extracted from the egg.

Mortality, 1 = 1 per cent.

Conclusions.

The effectiveness of salt water as compared with fresh in causing eggs to hatch and killing the young larvæ is clearly demonstrated by these experiments.

The last experiment, dealing with resistant eggs, greatly modifies, however, one's views as to the practical usefulness of salt water as

an insecticide for the destruction of eggs. For it is evident that though it causes the immediate hatching and destruction of recently laid eggs, a considerable proportion of resistant eggs that have been dry for a long time are not affected within a period of 44 hours, and that the larvæ contained in such eggs are not killed.

For coast towns, however, salt water, if the expense of pumping were not too heavy, might serve as a very valuable flushing agent for gutters, sewers and cess pits after clearing. It would, I am informed, probably kill any *Ankylostome* eggs with which it came in contact, and if used for flushing drainage ditches in streets and watering roads, would, in addition to its services in reducing the numbers of mosquito and *Ankylostome* eggs effectually prevent the growth of weeds on road side spaces. In Freetown the clearing and weeding such spaces must be a considerable annual cost.

In the event of the use of salt water for such purposes, it should be applied lavishly, in the light of the foregoing experiments, at the *close of the rains* if its full effectiveness for the destruction of *Stegomyia* eggs is to be obtained, because a large proportion of the eggs laid in gutters and pools, in culverts, etc., will not attain their full powers of resistance (resting capabilities) until the establishment of the dry season has caused the evaporation of water in moist places and dried the eggs.

Experiment No. LVII.

TRIAL TO ASCERTAIN IF THE STIMULUS TO HATCH EXERTED BY SALT WATER ON THE EGGS OF *STEGOMYIA FASCIATA* IS DUE TO ITS SPECIFIC GRAVITY OR SOME OTHER CAUSE.

In the absence of other means the specific gravity of filtered sea water from the Harbour was tested with a urinometer and found to be 25°. Loaf sugar was then added to tap water until the solution showed the same specific gravity.

200 cc. of the salt water, 200 cc. of the sugar solution, and 200 cc. of the tap water were placed in respective beakers referred to as "Salt," "Sugar" and "Tap" in the following record.

Two batches of eggs were used: (1) laid on filter paper and stored *dry* for 3 months; (2) eggs that had been laid on filter paper about 3 weeks and had been kept *dry* for 10 days. A portion of both batches of eggs was placed in each of the three beakers. The temperature of the fluids just prior to the immersion of the eggs was 85° F.

The number of eggs put into the beakers was :—

"Salt,"		"Sugar,"		"Tap,"	
20	recent.	28	recent.	20	recent.
291	old.	322	old.	324	old.
311		350		344	

RESULT.

Lot.	Number of days after immersion that hatching occurred.											Result of dissection of unhatched eggs after 24 days' immersion.
	1	2	3	4	5	6	10	12	16	18	22	
"Salt,"												
Living ...	...	...	...	...	...	...	...	...	...	...	...	All the larvæ in unhatched eggs
Dead ...	155	19	65	9	1	...	...	...	...	1	...	were dead.
Total ...	155	19	65	9	1	...	...	...	...	1	...	250 out of 311. Mortality in egg stage, 19 per cent.
"Sugar."												
Living ...	16	52	184	17	1	...	1	...	...	...	...	All the larvæ in unhatched eggs
Dead ...	8	2	...	1	2	...	...	...	...	...	...	were dead.
Total ...	24	54	184	18	3	...	1	...	...	...	...	284 out of 350. Mortality in egg stage, 19 per cent.
"Tap."												
Living ...	138	2	18	...	18	4	6	1	1	3	25	From unhatched eggs— Recent, 2 living larvæ extracted.
Dead ...	6	2	...	2	...	...	...	...	...	...	...	Old, 33 ,, ,, ,,
Total ...	144	4	18	2	18	4	6	1	1	3	25	266 hatched. 35 extracted.
												301 out of 344. Mortality in egg stage, 12 per cent.

All the pans containing the eggs were cooled in the ice chest on the 5th, 6th, 10th, 16th and 22nd days.

This result suggests that the efficacy of salt water in inducing the eggs to hatch sooner than they would in fresh water is not merely a question of specific gravity; if reference be made to the tests of the effect of petroleum-soft soap emulsion, Experiment No. LIII. 1 in 8,000 dilution, on the eggs of *S. fasciata* (page 159), we find much the same phenomena occurring. It seems probable that the action is likely to be related to the penetrating properties of the fluids used, possibly the ease of absorption by the (colloid) substance of which the bosses are formed is the crucial factor.

Immersion in the salt and sugar solution seems to have been responsible for an increase of mortality to the eggs, apart from that to the larvæ after hatching, of from 12 per cent. to 19 per cent.—the numbers involved being too large to admit of the explanation of the 7 per cent. increase in both cases being due to chance.

XII.—NOTE RESPECTING THE SIZE OF MESH FOR NETTING REQUIRED FOR USE AGAINST *STEGOMYIA FASCIATA.*

The wire gauze used for the mosquito house had a mesh of 16 × 16 to the inch; for the cages 12 × 12 to the inch mesh was used; and for the tubes, used to test the length of life of the adults, the mesh was 14 × 14 to the inch. A supply of large and small mesh cotton netting was also required to be used for repairs, covers to breeding pans, temporary cages, sleeves, etc. No definite size of mesh had been specified. Of the two sizes received one had a mesh of 10 × 13 to the inch, and the other 11 × 15 to the inch.

During the progress of the research it was found that a few well-grown (medium to large-sized) specimens of *S. fasciata* and also a number of *S. sugens* escaped from large cages, where they were well fed, through the 12 × 12 inch mesh. From the tubes, where they were crowded, and, presumably, more anxious to escape, large sized specimens, which had only recently emerged, got out in considerable numbers through 14 × 14 to the inch mesh. In order to carry out the tests for which these tubes had been specially constructed, it was found necessary to remake them with 18 × 18 to the inch mesh.

With cotton netting it was found that the mosquitoes, bred in pans covered with that having the smaller sized mesh of 11 × 15 to the inch, easily got out, presumably shortly after emergence, before their wings and limbs were fully dry; while wild specimens gained entrance through the coarser netting, having 10 × 13 mesh to the inch, and oviposited in some of the experimental pans.

No instances of escape from the mosquito house through the 16 × 16 to the inch mesh were discovered, and, as the mosquitoes in it were reared from larvæ that had ample food supplies and consequently were large sized specimens, it is probable that few, if any, escaped. Even for small specimens escape would have been difficult, owing to the fact that large numbers of spiders, both within and without, spun webs and trailed their threads over the wire gauze, so that, had this been of an even larger mesh, it would soon have been rendered mosquito-tight.

In view of the fact that, under starved conditions, specimens of *S. fasciata* are reared of little more than half the size of the normal insects, the advice of the authorities concerned with the mosquito work in the Panama Canal zone* that a mesh not larger than 18 × 18 to the inch should be used in relation to Yellow Fever screening, is fully justified and cannot be too strongly urged upon our own authorities.

It may be of interest to record that I was unable to get from any of the stores in Freetown or from the Public Works Department, a supply of netting of less than 12 × 16 to the inch, though I was informed by one of the stores that complete made-up nets could be supplied in the smaller mesh.† Subsequently, the Hospital authorities found some spare 20 × 20 to the inch netting which they had in store.

If by any means traders could be induced to stock nothing of of coarser mesh than 18 × 18 to the inch, it would be to the general welfare of the inhabitants in situations where any danger of Yellow Fever epidemics exists. The supplying of larger mesh netting, even for the purpose of repairs, is to be deprecated.

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* See "Monograph of the Mosquitoes of N. America, etc.," published by the Carnegie Institute, Vol. I., pages 363 and 364.

† Many of the nets I saw in actual use, including those at the Government rest house, were, however, of larger mesh.

XIII.—APPARATUS AND METHODS EMPLOYED.

Mosquito House. Plate 21, *page* 96.

This was designed by myself at the suggestion of Lt.-Col. Sir Ronald Ross. The woodwork was of unpainted teak, the stiffening framework of galvanized iron, and the wire gauze for the panels of phosphor-bronze. After eleven months' exposure to the weather at Freetown it was in perfect condition (*see* Figs. 21 and 22, pp 170 and 171).

Cages.

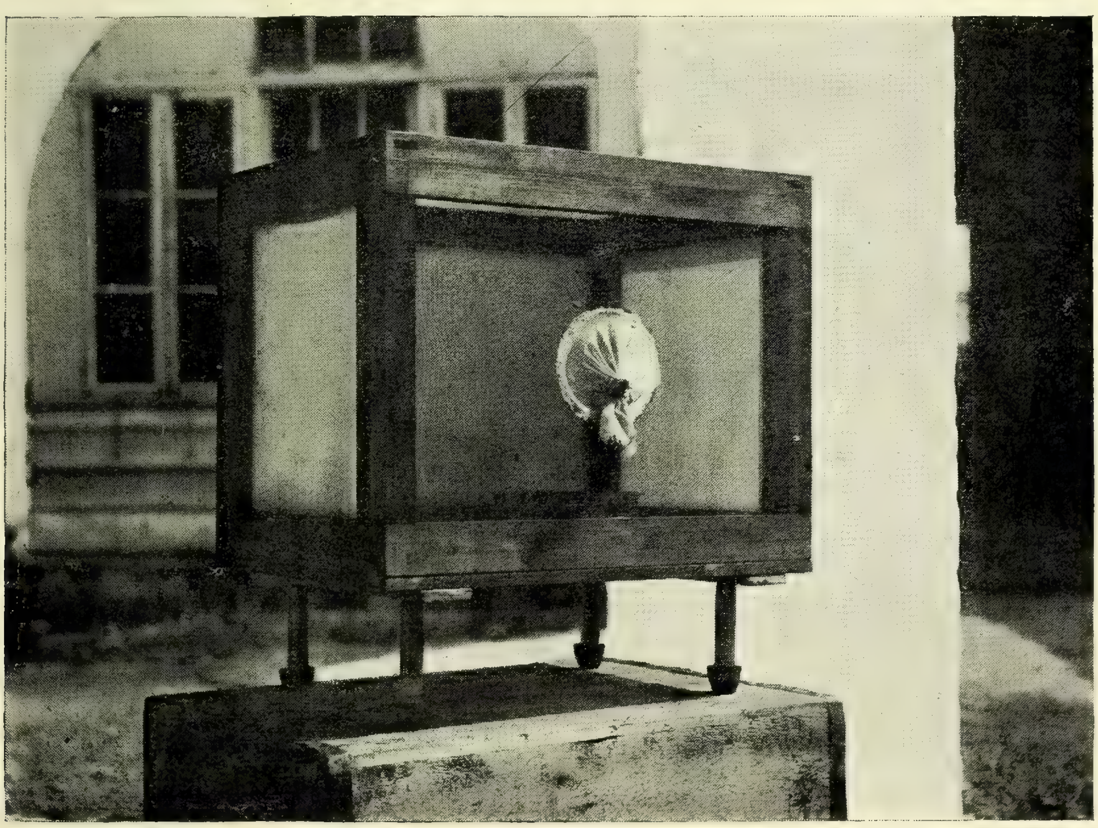

Plate No. 26.

A Mosquito Cage.

The floor boards were of teak with stiffening battens of galvanized iron, into which the legs screwed. The upper framework was of "flat oiled" pine. In the case of the cages intended for "infected" mosquitoes, the panels were of phosphor-bronze wire gauze. It was found convenient to cover this with thin cotton on the inner side.

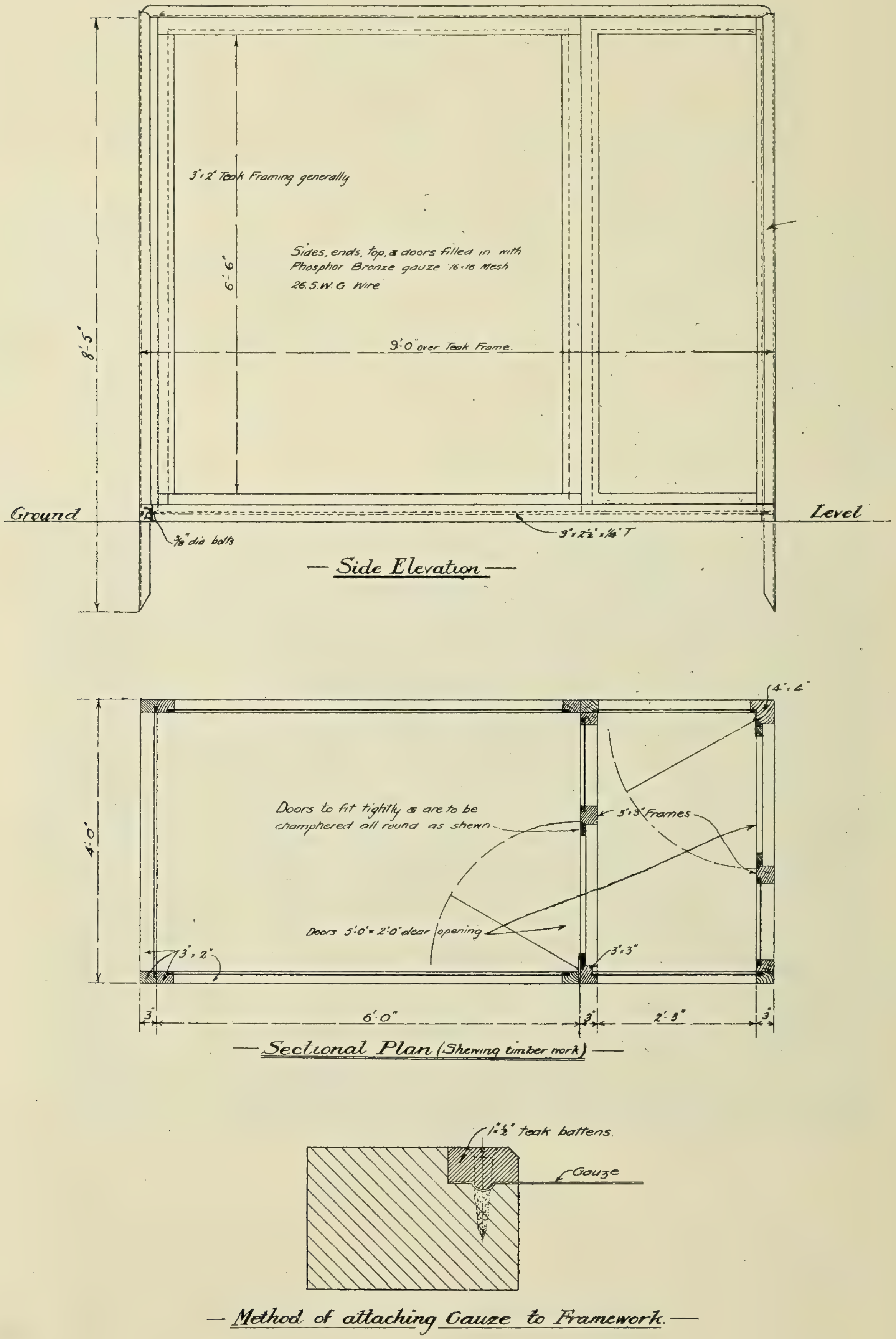

FIG 21. PLAN OF MOSQUITO HOUSE.

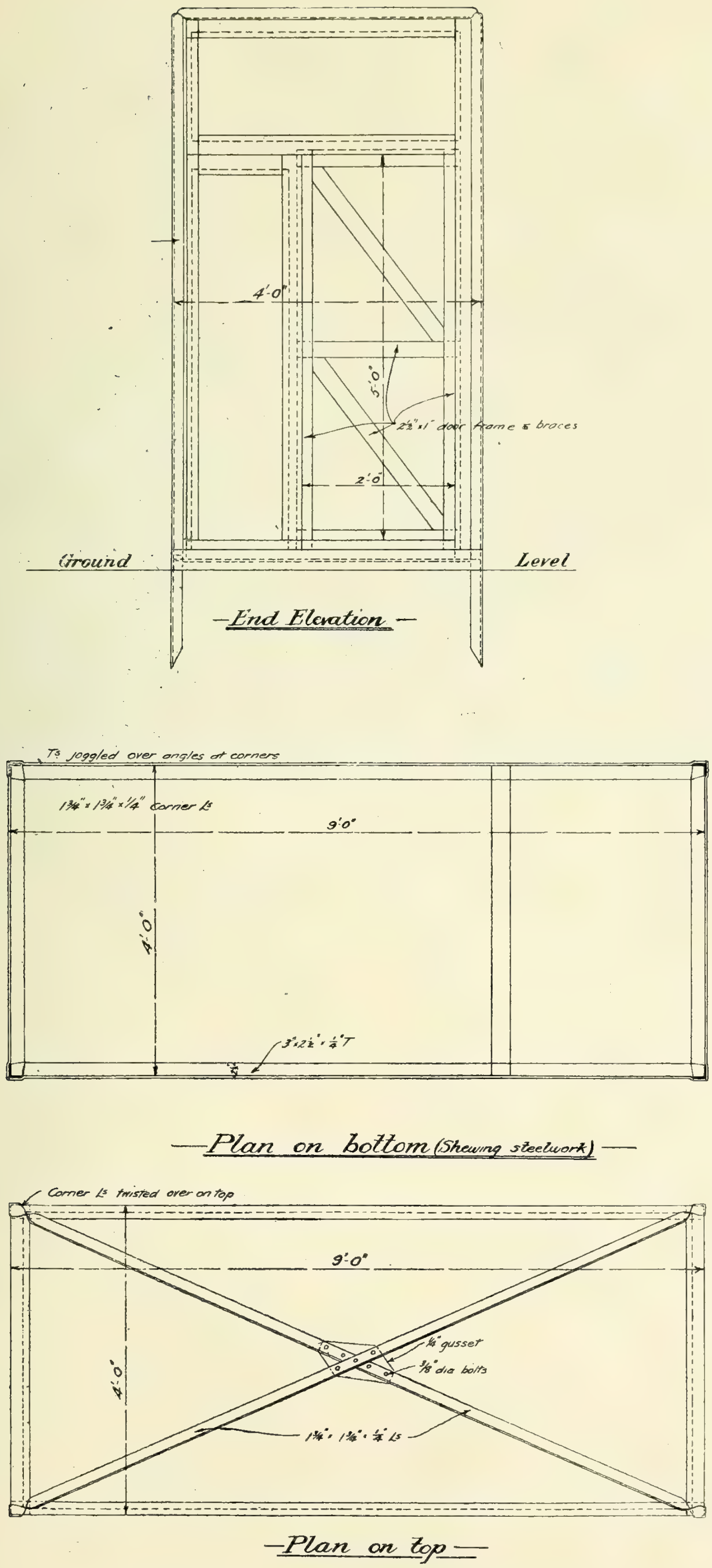

FIG. 22. PLAN OF MOSQUITO HOUSE.

For "uninfected" mosquitoes only the front panel, supporting the sleeve, was of wire gauze, the top and remaining sides being covered with cotton only. These cages, built to my own design, proved to be very serviceable and useful, and both in size and

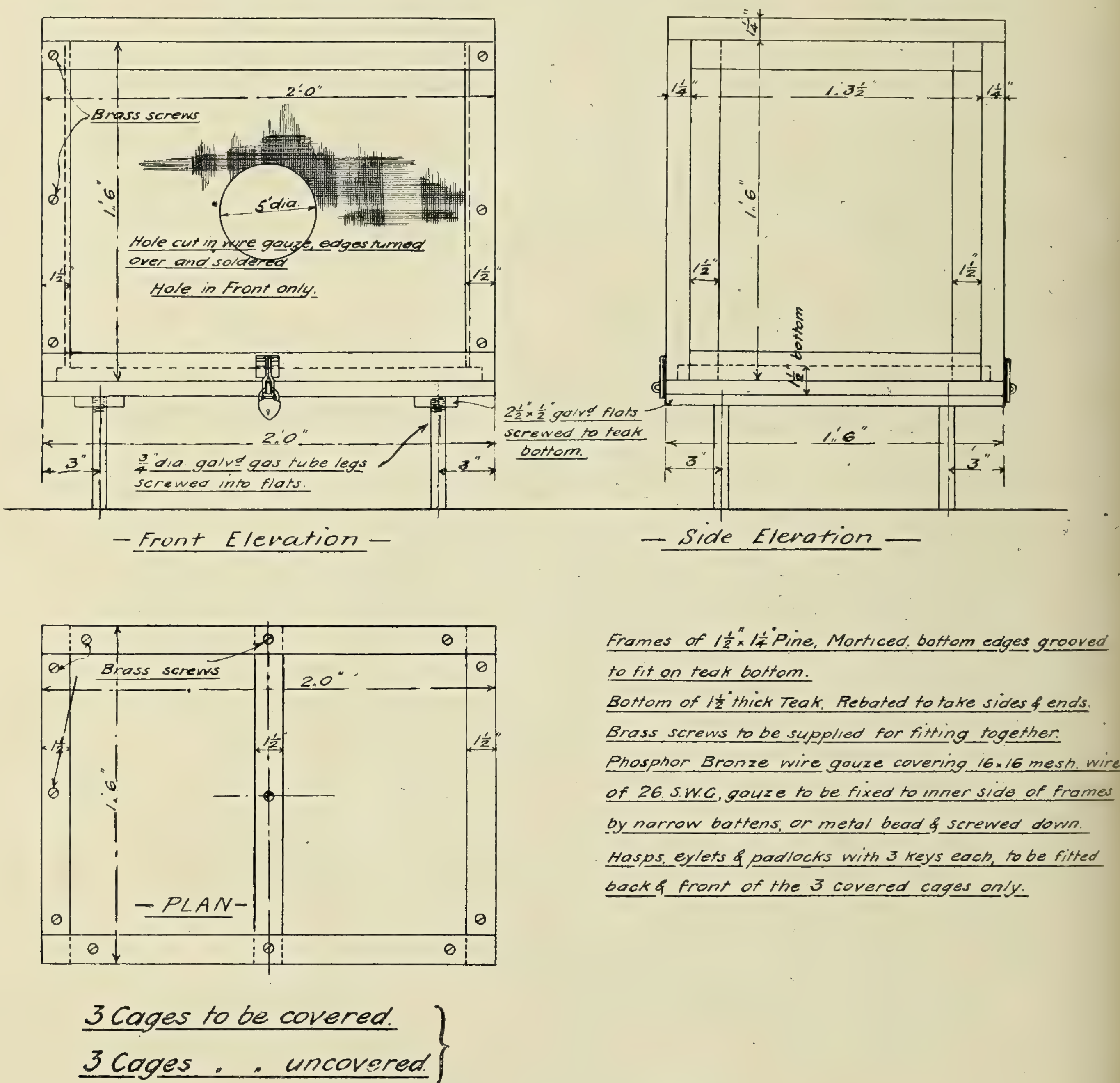

FIG. 23. PLAN OF CAGE.

construction are suitable for a wide range of insect breeding. They can be taken down in a few minutes, and when packed flat take up a minimum of room, so that they can be easily transported.

Pens.

These were of phosphor-bronze wire gauze, supported on a light galvanized iron frame. Their use was to cover stored eggs, pans

of water containing larvæ, or tubes containing adults when it was desired to leave these exposed in the open air (*see* Fig. 24, page 174).

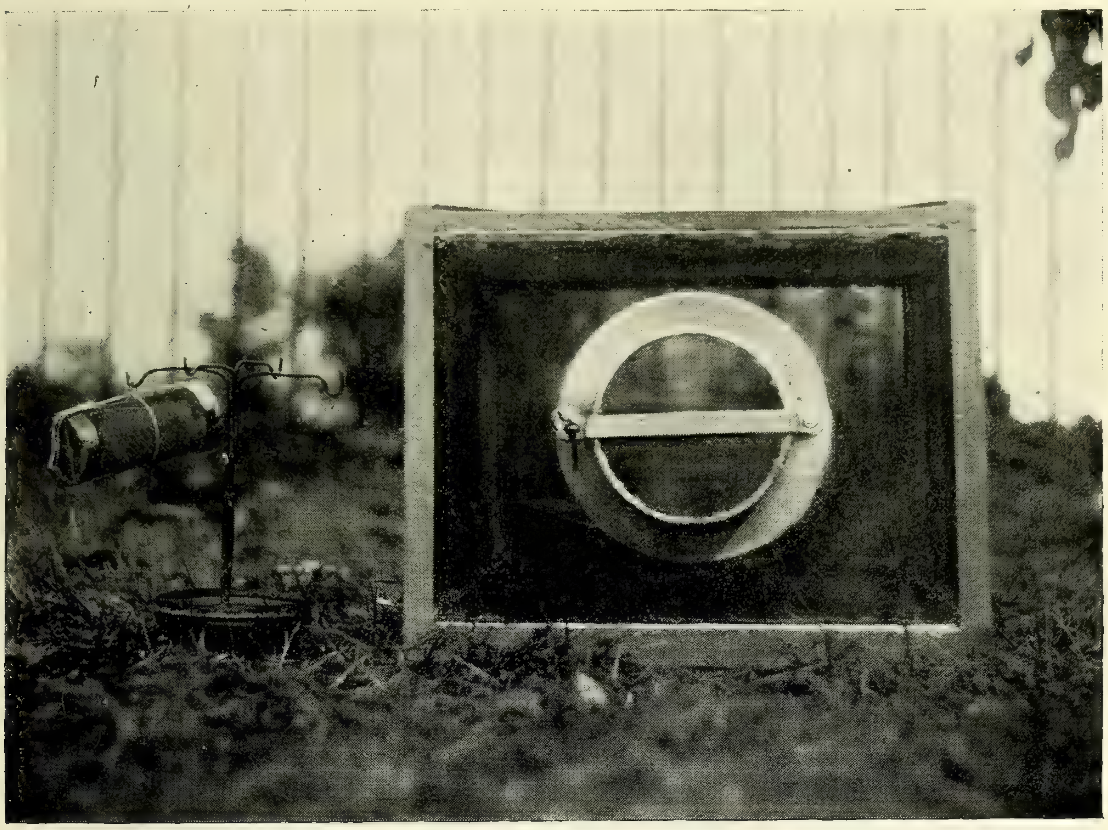

Plate No. 27.

Mosquito Pen and wire gauze tube for testing length of life of adults in various situations. Note method of suspension so as to isolate from ants.

Wire Gauze Tubes.

These were of wire gauze opening at either end (*see* Fig. 25, page 174); they were used to intern adult mosquitoes to test their length of life, and were also used to protect stored eggs from disturbance by small animals and the larger insects (*see* Plates Nos. 27 and 28).

Hurricane Lamp Chimneys.

These can be converted into useful little cages by covering the upper opening with fine gauze and putting the open end down on a pad of filter paper placed in a tin lid (*see* Plate No. 28, page 175).

Methods.

To obtain eggs.—The method mentioned by Christophers and Stephens (1908) of confining females in inverted screw-topped jars was found to answer well for single individuals. With *Stegomyia fasciata* and *S. sugens*, flooded blotting paper in the cover is sufficient to

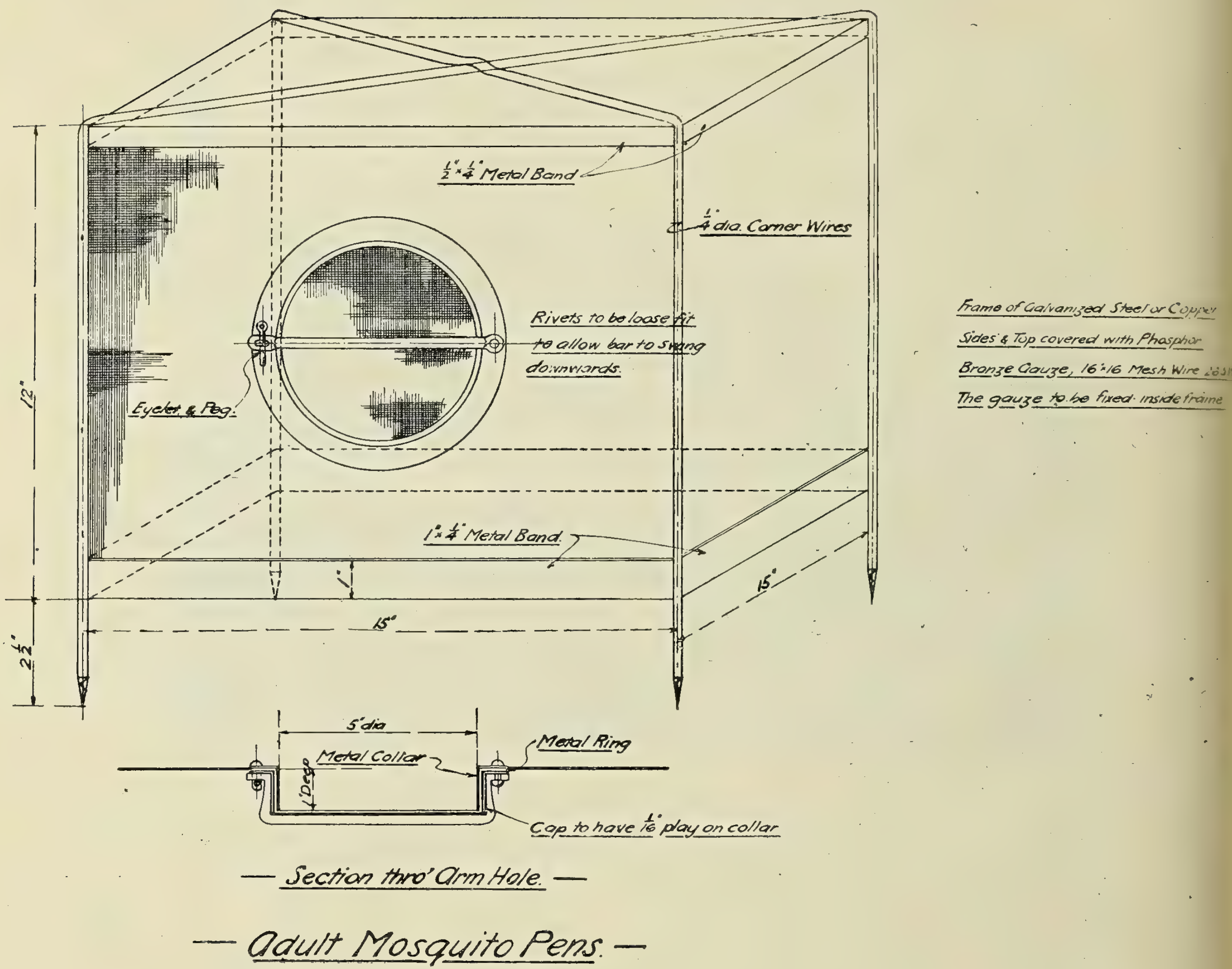

FIG. 24. PLAN OF PEN.

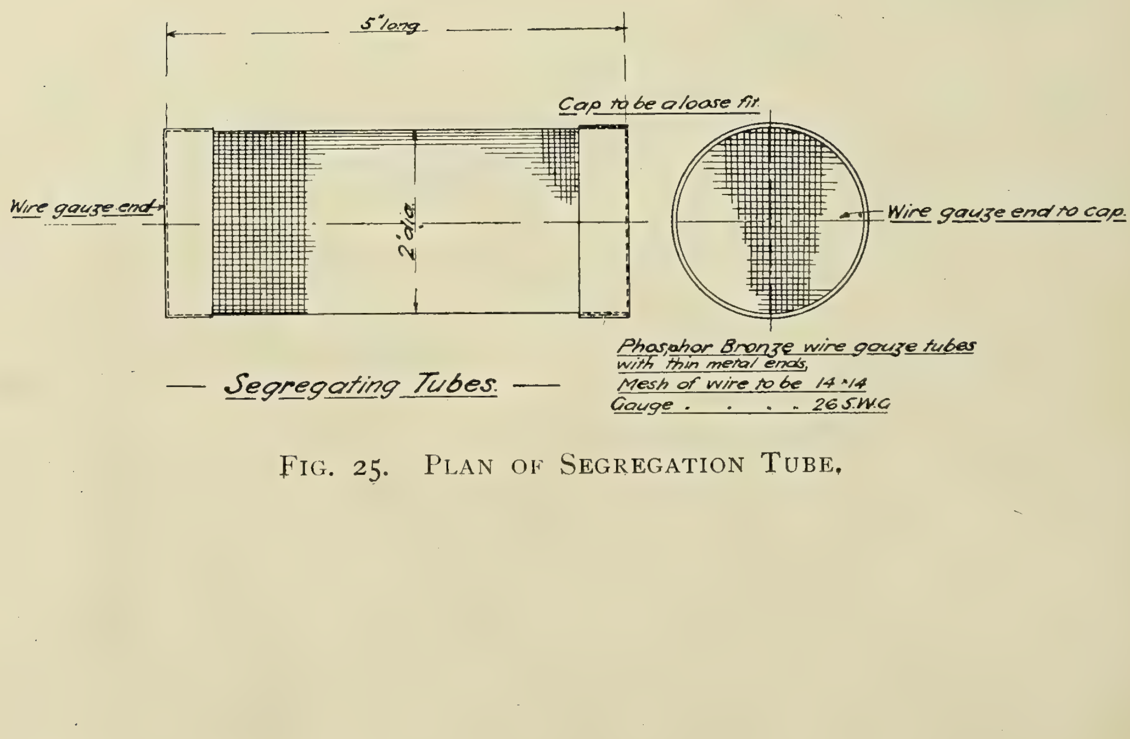

FIG. 25. PLAN OF SEGREGATION TUBE.

induce oviposition, but unless the rim of the jar fits quite accurately minute house ants, belonging to the group *Leptothorax*, may gain entrance and kill the mosquitoes. If an accurate record of the number of eggs deposited is desired, care must be taken to search the rim of the jar just above its point of contact with the blotting paper, as eggs are frequently deposited or stranded in this position.

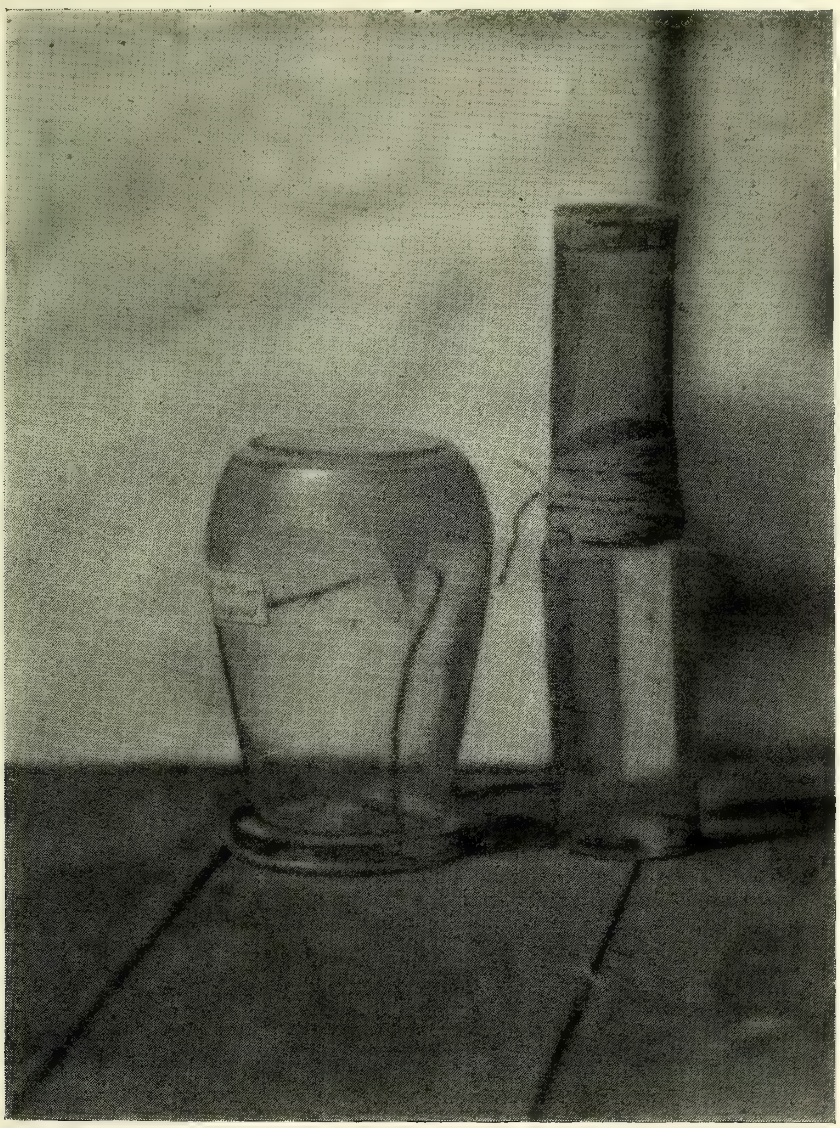

Plate No. 28.

Small Cage made from a hurricane lamp chimney, also method of arranging wire gauze tube over jar containing pupæ in order to avoid waste of time in transferring adults.

For *Stegomyia simpsoni* and *S. luteocephala* some larger and more elaborate arrangement of a small pool was generally needed before the females could be induced to lay, and the latter species seems to greatly prefer ovipositing on or in close proximity to a surface of wet wood.

When eggs are required in numbers it is best to keep a number of mosquitoes of both sexes in a large cage. A convenient method of collecting the eggs of *Stegomyia* under these circumstances is to place a pan of water in the cage with slips of filter or blotting paper arranged so that one end dips into the water and the other is turned back over the edge of the pan; by adopting this method the eggs can easily be removed and counted without disturbing them. The water in the pans should be allowed to slowly evaporate, so that the eggs are left above water level, and do not hatch as would be the case if the pans were re-filled. If eggs laid on a wooden surface are required, the sides of a willow chip box answer excellently, as the wood is absorbent and of light colour, and its curvature is retained sufficiently to allow of its standing upright upon its edge in a shallow pan of water.

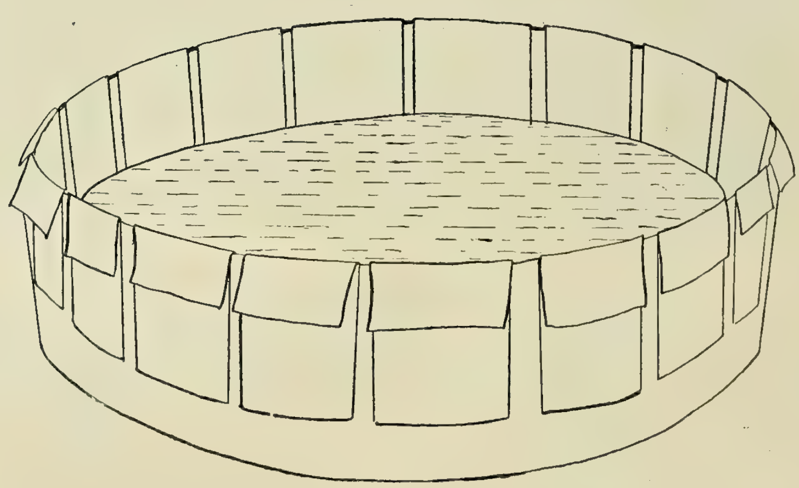

FIG. 26.

Hatching.—To test the hatching capacity of eggs laid by separate females or different batches of eggs laid by a single individual

requires daily observations, which may have to be continued for weeks together, and necessarily consume a great deal of time. If it is desired to submit the eggs to identical conditions the different batches will have to be kept separated from each other in the *same* pan of water. Two methods of fulfilling these conditions were employed. In the first the eggs were carefully submerged in small glass sporulating dishes, which were in their turn placed at the bottom of a large pan of water. It was found necessary to check the number of larvæ captured in the pan each day against the number of empty egg shells, and to do this the sporulating dishes had to be taken out of the pan for examination under a low-power microscope and replaced.

Plate No. 29.

Floating Docks. Method of testing the hatching of different batches of eggs under identical conditions.

Objections to this method were (1) that the eggs had to be completely submerged, and it has been stated, by Goeldi (see Carnegie Monograph, " Mosquitoes of North America," page 282), that continued submergence kills the eggs. Death rate from this cause is not by any means obvious in some of the experiments, but where *any* mortality at all has occurred, it is impossible to prove a negative. (2) Great care had to be taken in removing and

returning the small dishes to the large pan, in order to avoid scattering the eggs and mixing them. (3) The gradual accumulation of dirt and organic growth tended to obscure a free view of the eggs after two or three weeks' immersion.

An alternate method was devised of keeping the eggs in small floating docks (*see* Plate No. 29, page 177) with a fine gauze bottom made as follows. The top is taken out of the lid of a willow chip box, and the hoop is used to stretch a piece of motor veil (silk if possible) over the top of the box. Thread is wound round to prevent the box from coming to pieces when the water melts the glue with which it is fastened together. The bottom of the box is removed by soaking it in water, and three cork floats are pinned on to the sides at the level at which the dock is required to float.

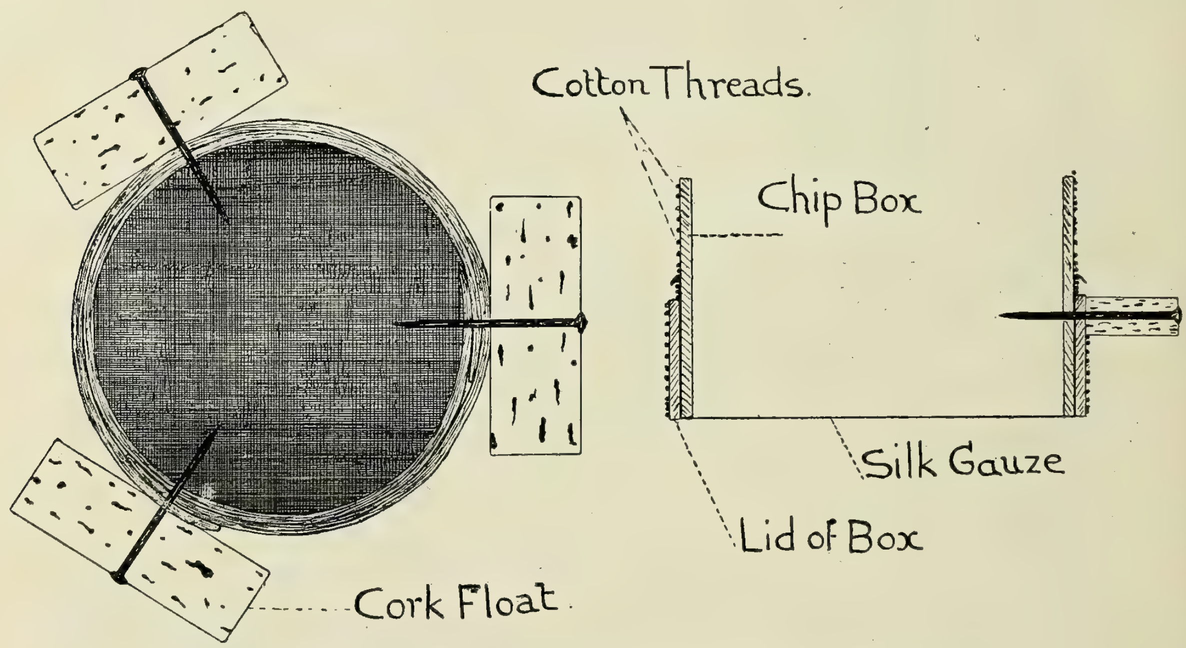

FIG. 27. PLAN AND ELEVATION OF FLOATING DOCKS.

By adopting this plan examination is facilitated, the necessity of submerging the eggs is avoided, and a great saving of time is effected, as the sinking of floating eggs is a tedious process. Its defects are that with long continued use the gauze rots and the wood and cork become water-logged and lose their bouyancy. The saving of time is so great, however, that the plan is strongly to be recommended in all cases where it is not necessary to carry the hatching test to its ultimate conclusion of waiting until every single egg has had a complete chance of hatching. In most cases it is practical to close the experiment at a definite date and open the remaining eggs to see if they are dead or contain living larvæ.

Methods with larvæ.—For sorting out and transferring newly hatched larvæ a pipette with a rubber teat affords an obvious and speedy method. It may also be used for larger larvæ and pupæ, but care must be taken with the latter that the aperture is sufficiently large, otherwise they are easily injured.

When counting or catching newly hatched larvæ in a glass dish, the use of a black card or paper placed beneath it is helpful and, if the dish is supported above instead of resting *on* the black surface it renders observation still easier. With older larvæ, that have fed, a pale background is just as effective, owing to the dark colouration of the contents of the alimentary canal.

Larvæ and, to a less marked extent, pupæ of *Stegomyia* always avoid light; advantage may be taken of this when they are in a glass receptacle to make them collect in a corner or to one side for the purpose of rapid capture.

Breeding pans should not be placed in the sun or a strong light, otherwise they develop a growth of green algæ which appears to be detrimental, possibly by way of competition, to the development of the insects.*

If it is desired to breed *Stegomyia fasciata* free of gregarine parasites care must be taken to collect the eggs with a camelhair brush as soon after laying as possible and transfer them to clean filter paper. It is probable, if the sporocysts are voided by the females as suggested by Ross, that the young larvæ may ingest them at their first meal immediately after hatching.

Breeding pans in large cages containing a number of insects, especially when their numbers are recruited from several sources, are almost certain to become infected in a short time, and will remain permanently infected unless frequently cleaned.

For rearing the larvæ almost any sort of organic matter put into the breeding pans will serve, though care should be taken to thoroughly adjust the quantity to the size of the pan and numbers of the larvæ. Any sort of grain, dead insects, fæces of animals, fallen leaves, or other vegetable refuse, blood clots, etc., have all given good results.

Methods with adults.—To obtain a prompt supply of adults, dark coloured pupæ should be selected for preference, as the darkening signifies that the adult is nearly ready to emerge. To avoid waste of time in catching and boxing or caging mosquitoes for experiment, it pays to capture and segregate pupæ in jars of such size that an easy

* Experiments now in progress suggest another possibility, *i.e.*, that strong light or sunshine checks the growth of bacteria.

junction between the box or small cage and the rim of the jar with a slip of paper is possible (*see* Plate No. 28, page 175). One of the advantages obtained, apart from the saving of time, is that the age of the specimens is accurately known to within a few hours.

For infection experiments the clipping of one or both the wings is a reasonable precaution. To do this it is necessary to use chloroform ether or some other vapour to stupify the insects. Under cool conditions, temperature up to 65° F., ether causes a lower death rate than chloroform, but with a temperature of 80° F. chloroform answers best. After the operation it is well to place the insects in a warm incubator up to blood heat, or, failing this, in a strong draught, as this expedites their recovery and lowers the mortality resulting from the use of the vapour.

In dissecting infected mosquitoes which prove refractory to the usual methods of manipulation, a dissecting needle ground to a triangular section may be run up between the body wall and the internal organs from anus to head. Another needle is then drawn along one of the sharpened angles, thus slitting the insect longitudinally. With a little practice the gut and stomach of insects, which have recently gorged themselves with blood, may be extracted without rupture in this way. The method is also applicable and very useful when making dissections of any small grub like insect larvæ—one of its advantages being that the skin can be spread out flat and mounted independently so that its external surface with spines, setæ, tubercles and spiracular openings can be examined with care.

XIV.—SUMMARY.

MOSQUITOES AT FREETOWN.

I.—Introductory Notes.

Judged by sight or feeling mosquitoes are scarce in Freetown, and though a round with one of the Inspectors of the Sanitary Department may correct this view in so far as the larval stage is concerned, the increase in numbers of both larvæ and their breeding places *outside* the town area afforts eloquent testimony to the efficiency of the Sanitary Administration.

Within the central area the larvæ of *Stegomyia fasciata* take precedence, followed by those of *Culiciomyia nebulosa*, which species appears a spasmodic breeder in comparison with the persistency of *S. fasciata*. *Culex decens* is also not uncommon. *S. simpsoni* breeds in water in the axils of the leaves of plants growing within the town, as do also *Uranotænia ornatus* and *Eretmopodites dracænæ*. *S. luteocephala*, *Ochlerotatus apicoannulatus*, *O. minutus*, *O. leucarthrius*, *Eretmopodites quinquevittatus* and *Culex nigripes* are also occasional breeders within the town area. Of the species of *Anopheles*, a few larvæ of (*Pyretophorus*) *costalis* only were taken in the town, but in the surrounding district this species breeds freely, being frequently present in rock pools with swarms of *S. sugens*. The breeding places of (*Myzomyia*) *funestus* are extensive areas of shallow trickling swamps lying east and west of the town.

II.—Bionomics of Stegomyia fasciata.

(A.) EGGS.

(*a.*) *Shape and structure.*—The dark spindle-shaped eggs of *S. fasciata* vary considerably in shape and size, affording specimens which approximate closely in general appearance to those of the allied *S. sugens*, *S. luteocephala* and *S. simpsoni*, all of which differ appreciably among themselves.

The bosses with which the eggs are studded are not mere structural excrescences of the shell, but are pockets containing small masses of a substance which, unlike chitin, is readily stained

by hæmatoxylin; these bosses are possibly connected with the ability which the eggs seem to possess of replacing moisture lost through desiccation.

(*b.*) *Laying.*—If actually laid on the water surface they are usually deposited so close to the margin as to become stranded by capillary action on the sides of the pools, or on partially submerged objects, such as dead leaves, lying in it. In many instances eggs were laid on wet surfaces quite beyond the limit of capillary action.

(*c.*) *Hatching and the conditions which control it. Experiments I. to XVIII.*—Incubation seems to invariably follow laying within 30 to 40 hours, at the Freetown temperature, but the hatching of any given batch may be distributed over a lengthy period. Apparently the eggs are endowed with a complex constitution, which allows of the whole of a batch hatching together, so soon as they are placed in water, or of a scattered emergence of the larvæ consistent with the view that some internal machinery which produces zonal or sectional hatching has been called into action. Experiment No. XVIII. suggests that the latency or activity of this machinery is determined by the conditions of humidity or drought which prevail *after* incubation. When a batch of dried eggs is placed in water a certain proportion generally hatch within a few minutes or hours, but others, apparently belonging to the same hatching zone, may resist the first or second immersion, yielding to some subsequent one. Similar powers of resistance will probably be shown by a proportion of the eggs in each hatching zone of a given batch.

After a series of experiments, Nos. IV. to XIII., in which various possible factors were tested, evidence was obtained that cooling to the extent of some 5° or 10° F. acted as a stimulus to induce the hatching of eggs that would otherwise have deferred doing so (Experiments Nos. XIV. to XVI.). A response to cooling accords well with the needs of the species, as a distributed emergence of larvæ so arranged allows of full advantage being taken of the increased facilities afforded for breeding in small and rapidly drying pools with the advent of rain.

Experiment No. XIX.—Agitation of the water, mentioned by Mitchell* as a factor in the hatching of eggs, failed to give any decisive result.

* "Mosquito Life," page 26.

Bacterial action would appear also to be an important factor in hatching and in some instances to be essential (*see* footnote on page 51).

(*d.*) *Period of viability. Experiment No. XX.*—The period during which the eggs retain their viability would seem to be to some extent conditioned by temperature, humidity and ventilation, but, owing to the destruction of stored eggs by book-lice (*Psocidæ*) (Experiment No. XXII.), no adequate statistical evidence on this point was obtained. The longest period of viability was 262 days; in another test large numbers hatched after 200 days' dry storage. When kept continually immersed some eggs did not hatch for periods of from two to five months. (Experiments Nos. V., VI. and VII. show examples).

(*e.*) *Temperatures which the eggs are able to survive. Experiment No. XXI.*—Eggs brought back from Freetown and those laid in England hatched after exposure to 28° F. and 30° F. for 24 hours, but none hatched after an exposure of 25 days. 24 to 28 hours at 96° F. did not greatly, if at all, affect the percentage hatching at Freetown. In the experiment carried out at the Lister Institute there was a marked difference in the hatching percentage of Freetown eggs and those laid in London after exposure to 96° F. A few hatched after 24 hours' exposure to 102° F., but all the eggs of a batch placed at 108° F. for 24 hours failed.

(*f.*) *Enemies of eggs. Experiment No. XXII.*—The only active enemy discovered was a species of book-lice (*Psocidæ*) which wrought immense havoc among the stocks of stored eggs. Ants, considering the untiring activity of their search for the smallest particle of food, seemed strangely indifferent to the eggs.

(*B*) Larvæ and Pupæ.

The larval period is conditioned by temperature and food, breeding tests dealing with the latter factor only were practicable at Freetown, although some trials concerning the survival limits in regard to temperature were carried out.

(*a.*) *Experiments Nos. XXIII. to XXV.*—A very wide range of organic matter will serve as food for the larvæ of *S. fasciata*, and the water may be so heavily charged as to become foul and thick, without harming the larvæ, so long as it remains free of scum, floating oil or fat.

(*b.*) *Period of larval life.*— Under the most favourable circumstances the larval life is passed within four days ; on the other hand, with a scarcity of food, it is prolonged for upwards of 70 days. In tap water of average purity the larvæ are unable to pass the first moult apart from added nutriment, but they continue to mark time until the death of their fellows enables a few to complete their development. Probably, in an uncovered breeding pool the fall of organic dust would be sufficient to afford food for a fair number of larvæ.

(*c.*) *Small adults reared from starved larvæ.*—Shortage of food results in the production of small sized adults—a somewhat important point on the practical side. Well-covered cleanly cisterns therefore require covers of specially small mesh wire gauze (not less than 18 × 18), there being always a danger that eggs will be washed in from gutters during rain.

(*d.*) *Interaction between larval growth and the development of bacteria. Experiments Nos. XXVII. and XXVIII.*—Experiments show an apparent association between the speed of larval growth and the development of bacteria. The scarcity of bacteria in the gut of larvæ taken from water swarming with these organisms is probably evidence of the speed with which bacteria are assimilated, as it seems improbable that, by the use of the mouth brushes, or any other means, the larvæ could avoid swallowing them. The marked clearing action of mosquito larvæ in foul water affords a parallel instance of interaction between them and the bacteria, although this might be a secondary effect due to the absorption of organic matter by the larvæ, and not the ingestion of the bacteria. Experiment No. XXVIII. affords evidence of this interaction, and shows that, when two similarly stocked beakers were prepared, in one of which bacterial action was given four days' start of the larvæ, the bacteria absorbed nutriment, which, even in the event of the larvæ devouring them, could not be regained.

(*e.*) *Temperature which the larvæ and pupæ are able to survive. Experiment No. XXX.*—Larval growth and pupal development proceeded normally in a large tin exposed to full sunlight—the temperature of the water rising to 103° on one occasion. Trials with larvæ and pupæ taken from this tin showed that the upper limit of temperature they could survive lay between 112° F. and 115° F. As regards cold, pupæ reared at 80° F. remained active at 50° F., but about half the larvæ submitted to the test became stiff and immobile at this temperature, quite irrespective of size. With a further

reduction to 40° F. all the larvæ became immobile at the bottom, while the pupæ, with two exceptions, also lost all power of movement, but remained at the top. Both larvæ and pupæ recovered when the temperature was allowed to rise, but there was a mortality of 6 out of 40 larvæ and 2 out of 24 pupæ submitted to the test.

(*f.*) *Survival of larvæ and pupæ when submerged. Experiment No. XXIX.*—183 larvæ and 40 pupæ were submerged in a wire gauze tube of 18 × 18 mesh for 20 hours; 8 per cent. of the pupæ and 27 per cent. of the larvæ survived.

(*g.*) *Survival of larvæ on wet filter paper.*—Two larvæ in their fourth skins were stranded on a piece of filter paper which was kept continually wet; one lived 3 and the other 10 days.

(*h.*) *Enemies of the larvæ. Experiment No. XXXII.*—As pointed out by MacGregor,* the larger larvæ of *S. fasciata* apparently consume the smaller ones; mortality from this source seems to be limited to larvæ undergoing the first moult being ingested by those in their fourth instar. The habit of breeding in small collections of water, while saving the species from the attacks of many enemies, enhances the danger of fratricide, but the species is safeguarded from this risk to a considerable extent by the intermittent hatching of the eggs. Tadpoles, as stated by several authorities, certainly do not attack well-grown mosquito larvæ, though they probably have a checking influence, owing to competition for food. It seems possible, however, that the small larvæ undergoing their first moult, might be engulfed by tadpoles with other food. A small water-bug, found in rock pools, attacks the larvæ of *S. sugens*, and probably other species as well, but it was never seen in sufficient numbers to be a serious check. A species of *Ostracoda*, belonging to the genus *Cyprii*, seems to be inimical to mosquito larvæ, apparently as a competitor for food.

(*C.*) Adults.

(*a.*) *Pairing and feeding.*—In captivity there seems to be no regular precedence either of pairing or feeding; both functions are practised at any hour of the day or night—late afternoon being perhaps most favoured. The act of pairing commences during flight and occupies only a few moments, but is possibly repeated at frequent intervals. A single male is able to impregnate 10 females more or less effectually, and to fertilize 750 eggs (Experiments Nos. XLVI. and XLVII).

* "Journal of Tropical Medicine and Hygiene," No. 17, Vol. XVIII, 1st Sept., 1915, page 195.

(*b.*) *Development of eggs. On a single meal of blood and also on blood other than human.*—In feeding satiety is evidently aimed at, and an interrupted meal is completed as speedily as possible ; a perspiring skin attracts more readily than a dry one. A single full meal of blood is sufficient for egg production in many cases, possibly for all, though the eggs are sometimes retained for many days. The blood of rats, dogs, goats and bandicoots seems just as effective for the development of the ovaries as human blood, but blood taken up from a living host seems to be a practical, though not a theoretical, necessity. *Fed on blood mixed with syrup. Experiments Nos. XLIV. and XLV.*—A single fertile egg was laid when the only food given was blood from a sheep mixed with syrup.

(*c.*) *Feeding in relation to egg laying.*—Females with ripe ovaries usually refuse to feed until they have deposited the bulk of their eggs, when they feed greedily. Females in their period of greatest vigour tend to develop and lay their eggs in masses at about three-day intervals, feeding on the first and second days after depositing their eggs, and fasting while the ovaries are full ; Experiment No. IX. and the Appendix to Experiment No. XLVI. are typical instances. The female used in the latter experiment laid 837 eggs in twelve batches, exclusive of odd eggs, while the former, in 22 days, laid 712 eggs in fifteen batches.

(*d.*) *Retention of eggs.*—Fertilized females that have only received a single meal of blood may retain their eggs for a considerable period before laying them ; Experiment Nos. XLI. and XLII. show examples.

(*e.*) *Choice of situation for depositing eggs.*—Tests showed that the widely-held opinion that the kitchen and boys' quarters are the most likely situations to look for *S. fasciata* was in the main correct, but it seems questionable if the preference is not as much due to the likelihood of there being foul water present, as to the chance of feeding on the boys. No eggs were ever deposited in a jar of clean water kept in the boys' bedroom.

In the mosquito house a wooden tub or tin pans were favoured as against a galvanized iron pail ; Experiment No. XXXIII.

(*f.*) *Baits to attract pregnant females.*—Experiment No. XXXIV. affords evidence which seems fairly conclusive of some selection by the females, but it was by no means final, and is as suggestive of subordination to their own tastes as to the needs of their progeny.

(*g.*) *Eggs not laid apart from wet surfaces. Experiment No. XLIII.*—Fertilized females regularly fed on human blood would not oviposit when no wet surface or water was available.

(*h.*) *Length of adult life. Experiment Nos. XXXV. to XL.*—The longest lived specimen was the female used in Experiment No. IX., which was killed by ants after 95 days. The longest lived male life was 50 days, in Experiment No. XXXVII. Average lives of 29 days for males and 44 days for females are shown in Experiment No. XXXVIII., the specimens being fed on syrup and kept in a still and, for Freetown, not very moist atmosphere. Specimens kept in wire gauze tubes give very much lower averages, and no evidence was obtained that *S. fasciata* can habitually, or is likely, save under very exceptional circumstances, to tide over the dry season in the adult stage.

(*i.*) *Enemies in the adult stage. Experiment No. XLVIII.*—Owing to its retiring habits, *S. fasciata* probably suffers more from wingless than winged foes once it has gained entrance to a dwelling. Ants proved themselves to be deadly foes to caged mosquitoes; two species of spiders, one a small web spinner, the other larger, spinning no regular web, practically lived on *S. fasciata* in the mosquito house, and a small flattened scorpion was also discovered, which ate large numbers when confined in the same box with it. Young mantidæ were also found to capture and devour them. Ants, spiders and, perhaps, the scorpion are probably serious enemies even to active, unconfined specimens; the continual waving of the raised hind legs of the resting insects is, I suspect, a measure of preparedness to avoid attack by wingless foes.

A slender wall-haunting lizard quickly cleared a large cage of *S. fasciata* and probably acts as a salutary check to their increase.

III.—Parasites.

The only parasites encountered were a gregarine *Lankesteria culicis* Wenyon and a species of yeast.

IV.—Sterility of the Pupal Gut.

Experiments carried out in collaboration with Dr. G. G. Butler, although not conclusive, point to the probability of the sterility of the pupal gut, in so far as infection by bacteria is concerned.

V.—Notes relating to the Life History of some Related and Associated Species.

S. sugens.—The eggs are similar in structure and hatching habits to those of *S. fasciata*—cooling acting as a stimulus; larvæ are quite as rapid in development; pupation may occur within three days of hatching. The adults have many traits which suggest that their habits are more primitive than those of *S. fasciata*, which shows the characteristic laxness which seems so frequently to follow the close association of animals with man.

S. simpsoni.—Captive females fed heavily on human blood, but showed a decided preference for feeding at night. No pairings were seen, nor were any fertile eggs laid. The breeding of specimens from a collection of dry leaves taken in a water-hole proves that the species is able to resist drought, and is undoubtedly fitted to pass the dry season in the egg stage.

S. luteocephala.—The remarks made in reference to *S. simpsoni* are generally applicable to this species. Only infertile eggs were obtained, but the insects showed a decided preference for ovipositing on wood. The larvæ show some ability to survive among wet leaves.

Ochlerotatus apicoannulatus.—This species is also fitted to survive drought in the egg stage; the females bite readily and occasionally fill themselves with human blood. Pairing was never witnessed, nor were any eggs laid.

O. minutus.—Females of this species bit frequently and occasionally fed well on human blood. No eggs were obtained.

Uranotænia ornatus.—Reared from larvæ could not be induced to feed at all, and survived for less than two days.

Eretmopodites quinquevittatus.—The females of this and other species of the genus occasionally feed greedily on human blood. Pairing took place in a very small cage. The eggs are laid in twos and threes and vary greatly in size, being usually much larger than those of *Stegomyia*. Some cement appeared to be used to attach them just at or below water level. Fertile eggs failed to survive drying, but others of the same batch, which were kept in water, duly hatched. The larvæ are of the *Stegomyia* pattern, but are even more slender in build, and in habit are confirmed bottom feeders. The fourth skin larva retains the habit of browsing on the sides and bottom of the breeding pan that is characteristic of young larvæ of *S. fasciata*.

VI.—Eggs laid on fallen leaves in water-holes.

Eggs are laid on fallen leaves lying in water-holes. The following species were bred from leaves taken from an empty water-hole in January and immersed in March :—

233 specimens of *S. fasciata*; 24 of *S. simpsoni*; 81 of *S. luteocephala*, and 14 *Ochlerotatus apicoannulatus*.

VII.—Meteorological conditions as affecting breeding and distribution.

The early tornadoes which herald the breaking of the dry season begin as dry squalls with but little rain, and would afford an efficient means of bringing mosquitoes from the outlying districts into Freetown; this would apply especially to the *Anopheles* mosquitoes. At the onset of the rains breeding is necessarily restricted to a few pools in favourable situations; later these will be rendered untenable, but the insects reared in them will distribute and find other smaller and more numerous pools available as the showers increase in number and intensity. The small number of places available for early breeding should make it possible to schedule and treat them at short and regular intervals at the very commencement of the rains, even if outside the bounds of the regular sanitary district.

VIII.—Experiments dealing with the destruction of S. fasciata. Experiments Nos. XLIX., LI., LII., LIII.

Naphthalene at 1 in 4,000, under the conditions of Experiment No. LI. is an effective larvicide; at 1 in 8,000 it is more effective than petroleum, but allows of a few survivors. Soft soap, at less strength than 1 in 1,000, is not an effective larvicide.

Emulsions of soft soap and petroleum are far more effective larvicides than either of them used separately, killing all larvæ and pupæ at 1 in 16,000 (water temperature about 80°, experimental pans covered with cheese cloth). With naphthalene added to the emulsion it was equally effective at 1 in 20,000.

As against submerged eggs petroleum and soft soap emulsion at 1 in 8,000 is not effective in killing the larvæ within the eggs. It has the result, however, of inducing a high percentage of the less resistant eggs to hatch at once, when the young larvæ are killed.

IX.—Effect of salt water on larvæ, pupæ and eggs of S. fasciata. Experiments Nos. LIV. to LVII.

Salt water (from Freetown Harbour) speedily kills the larvæ of *S. fasciata* but does not destroy the pupæ.

As against the eggs, though it does not destroy them, it causes a high percentage of the less resistant ones to hatch at once and a considerable percentage of the specially resistant. The young larvæ, after hatching, are speedily killed by it. The use of salt water for flushing culverts and gutters and watering roads might, if practicable, prove very beneficial. The effect of salt water as a stimulus to hatching appears to be unconnected with its specific gravity; a solution of sugar of the same specific gravity gave different results and both differed from the tap water control. Both solutions, however, were apparently responsible for a mortality of 7 per cent.

X.—Size of the Mesh of Netting for use against S. fasciata.

Adults can get through 10×13 cotton netting; they also pass 11×15 of the same material, and 14×14 wire gauze. No evidence of normal specimens escaping through 16×16 wire gauze occurred, but there is little doubt that the dwarf specimens caused by scarcity of food could do so. As suggested by the authorities of the Panama Canal Zone, for safety a mesh of not less than 18×18 should be used.

XI.—Methods and Apparatus.

This section deals with the apparatus used in this research, and the methods adopted in carrying out breeding and other experiments.

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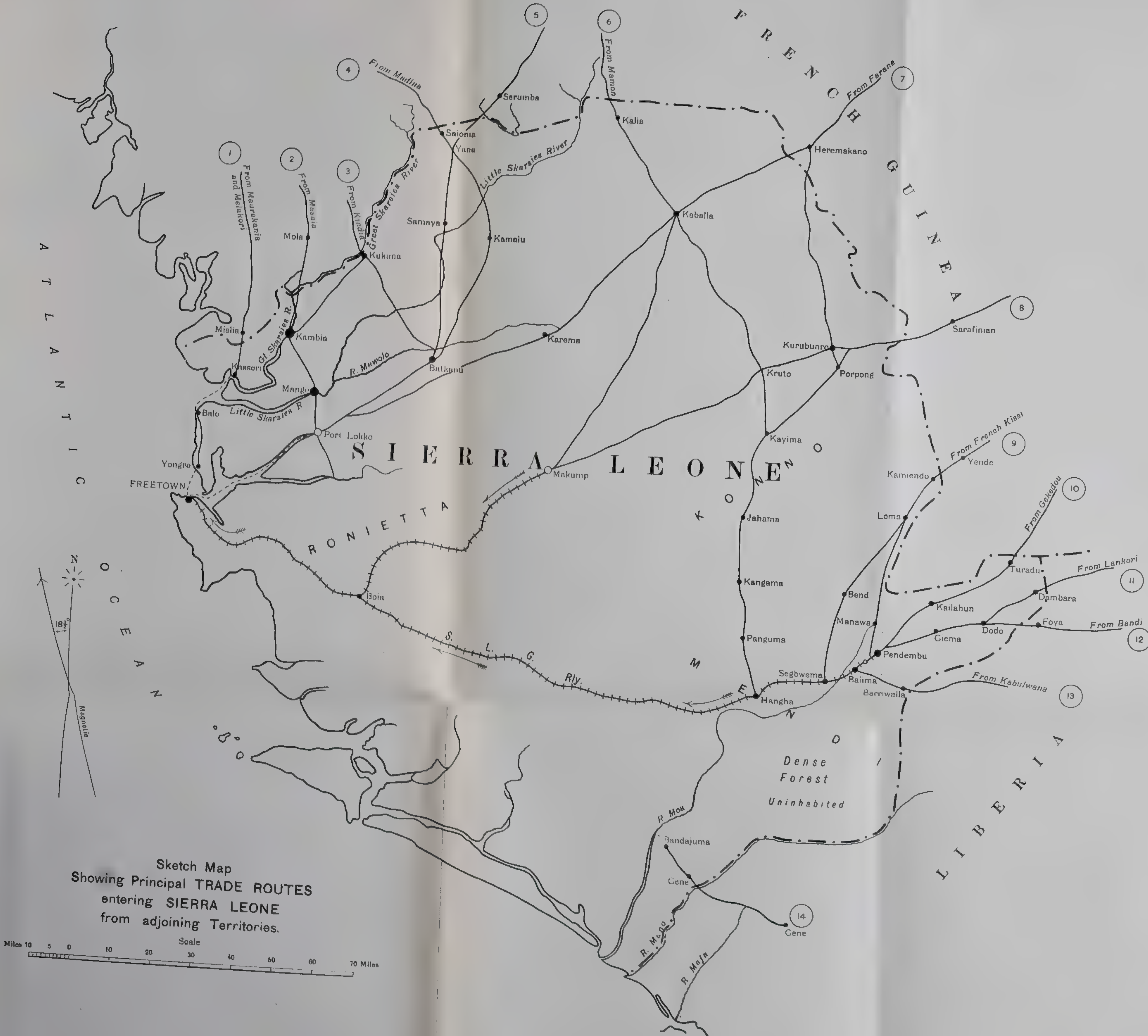

Sketch Map
Showing Principal TRADE ROUTES
entering SIERRA LEONE
from adjoining Territories.

Ordnance Survey Office, Southampton, 1916.

YELLOW FEVER COMMISSION (WEST AFRICA).

CORRESPONDENCE RELATING TO THE POSSIBILITY OF THE INTRODUCTION OF YELLOW FEVER BY LAND INTO SIERRA LEONE.

At an early stage in this enquiry the Yellow Fever (West Africa) Commission thought it desirable to obtain some information in regard to the possibility of the introduction of Yellow Fever in the ordinary course of overland trade between Sierra Leone and the neighbouring Dependencies. The following was received in reply :—

SIERRA LEONE.

THE GOVERNOR TO THE SECRETARY OF STATE.

(Received 28th July, 1913.)

Government House, Sierra Leone,
16*th July*, 1913.

SIR,

In accordance with your instructions, I have the honour to transmit a report on the chief land routes for traffic coming into Sierra Leone from the surrounding French and Liberian territories, accompanied by a sketch map.

I may mention that the report and sketch map have been compiled by the Officer Commanding the Sierra Leone Battalion, West African Frontier Force,* from the several reports and sketch maps furnished by the District Commissioners in the Protectorate.

I have, &c.,

E. M. MEREWETHER,
Governor.

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* The late Major (temporary Lieutenant-Colonel) G. P. Newstead, Suffolk Regiment.

[*Enclosure.*]

Report on Principal Trade Routes coming into Sierra Leone from French Guinea and Liberia adjoining.

The routes are numbered from West to East from 1 to 12, corresponding with those shown on the accompanying sketch map.

No. 1. From Maurikania and Mellakori. Enters the Protectorate at Mislaia, thence to Kaseri, by canoe to Balu, by road to Yongre, and thence by canoe to Freetown.

Trade chiefly cattle for cash and rice.

No. 2. From Massaia and Mola.—Through Kambia, Mange, Port Lokko and Magbile into the Ronietta District.

Trade chiefly cattle for cash.

No. 3. From Kindia.—Enters the Protectorate at Kukuna and passes thence

(*a*) to Batkanu ;
(*b*) to Kambia, Mange, and Port Lokko ;
(*c*) to Mabanta and Port Lokko.

Trade chiefly cattle for kola nuts.

No. 4. From Medina.—Enters the Protectorate at Saionia and follows road to Batkanu *viâ* Yana and passes through

(*a*) Samaya and Laminaya ;
(*b*) Samaya, Sassa, and Wonkifu ;
(*c*) Kamakuia and Kamalu.

A considerable trade is done on these routes in cattle for kola nuts.

No. 5. From Serumba.—Direct to Yana and thence through Kamalu to Batkanu.

Trade as in Numbers 3 and 4.

No. 6. From Mamon.—Through Kalia to Kaballa and thence

(*a*) through Karema to Port Lokko. This is the direct road, good road, and much used ;
(*b*) through Mabonto to Boia Extension Railhead. Much used ;
(*c*) through Kruto and Kayima to the Mendi country and large towns on the Eastern Section of the Railway.

Trade chiefly cattle and other produce.

No. 7. From Farana.—Enters the Protectorate near Heremakona and proceeds thence to

(*a*) Kaballa and on to Port Lokko as in 6 (*a*);

(*b*) Kaballa and on to Boia Extension Railhead as in 6 (*b*);

(*c*) Krubum and Kayima, thence to Mendi country as in 6 (*c*).

Farana is a large administrative post. The road from here to Kaballa is kept well open and much trade passes.

No. 8. From Sarafinian. Passes to Krubum and thence to Boia Extension Railhead *viâ* Kruto.

This road is difficult and hilly in places and is not extensively used.

No. 9. From French Kissi.—Enters the Protectorate at Kamiendo and passes through Loma to the Railway at

(*a*) Segbwema *viâ* Bendu;

(*b*) Pendembu *viâ* Komatendu.

There is also a subsidiary road from Korumba joining at Manawa.

No. 10. From Gekedu (French Kissi).—Crosses the Moa River into the Protectorate near Turadu and passes *viâ* Kailahun to Pendembu and Baiima. Largely used by the Upper Kissi, Sangaras, &c. from French Guinea.

Trade chiefly cattle and produce for cash, goods and utensils.

No. 11. From Lankorri Districts (Liberian).—Enters the Protectorate through Dambarra and passes thence *viâ* Dodo and Giema to Pendembu.

The trade consists of palm kernels, &c., for cloths and goods.

No. 12. From Bandi country.—Through Kolahun and Foya (Liberia). Strikes the main road through Dodo and Giema to Pendembu and Baiima. Extensively used.

Trade chiefly produce for goods.

No. 13. From South of the Mauwa River (Liberia).—Enters through Kebawana (Liberian Customs station) and passes through Barriwalla to Baiima.

Trade as in No. 12.

No. 14. From Barclay Gene to British Gene. The country between routes 13 and 14 consists chiefly of dense forest-clad hills, practically uninhabited, and there are no routes carrying any considerable traffic.

South of route No. 14 the trade with Liberia would appear to be carried chiefly by sea.

YELLOW FEVER COMMISSION (WEST AFRICA).

CORRESPONDENCE RELATING TO THE POSSIBILITY OF THE INTRODUCTION OF YELLOW FEVER BY LAND INTO THE GOLD COAST.

At an early stage in this enquiry the Yellow Fever (West Africa) Commission thought it desirable to obtain some information in regard to the possibility of the introduction of Yellow Fever in the ordinary course of overland trade between the Gold Coast and the neighbouring Dependencies. The following were received in reply :—

GOLD COAST.

THE GOVERNOR TO THE SECRETARY OF STATE.

(Received 11th May, 1914.)

Government House, Accra,
23rd April, 1914.

SIR,

I have the honour to forward herewith, for your information, a tabulated statement in which is embodied all the information at my disposal on the subject of trade routes leading into this Colony, and two copies of the $\frac{1}{1,000,000}$ map*, on which the routes in question are marked. The numbers given in the final column of the tabulated statement correspond with the numbers marked against the trade routes shown on the map.

Similar information with regard to the trade routes leading into Ashanti and the Northern Territories is being collected, and will be forwarded to you as soon as it is received.

I have, &c.,

HUGH CLIFFORD,
Governor.

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* Map A of the Gold Coast, &c.

MAP A.

UPPER SENEGAL AND NIGER
TOGOLAND
IVORY COAST
NORTHERN TERRITORIES
NORTH WESTERN DISTRICT
NORTH EASTERN DISTRICT
SOUTHERN DISTRICT
GRUNSHI
DAGARTI
MAMPRUSI
DAGOMBA
GONJA
TAMALE
YENDI
GAMBAGA
Bole
Salaga
Bole
Daboya
Yagaba
Walembele
Tumu
Lorha
Bussie
Binduri
Zebilla
Bawku
Karaga
Savelugu
Kumbungu
Kpabia
Jasayile
Brumase
Wa
Kintampo
No roads or villages
BANKUMA HILLS
Undulating Uninhabited Prairie
3°
2°
1°
0°
11°
10°
9°

MAP
OF THE
GOLD COAST, ASHANTI,
AND
NORTHERN TERRITORIES.
Illustrating despateh from the Governor of the Gold Coast 23rd April 1914, included in Vol. III, Investigators' Reports, Yellow Fever (West Africa) Commission.
REFERENCE
Railways completed (single)
Railways in progress
Well defined main roads
Other routes
Telegraph along roads
Telegraph Office T.
Postal Telegraph Office P.T.
Boundary International
Boundary Colonial
Boundary Provincial
Boundary District
Ruins
Falls, Rapids
Trade routes shown in Green thus
IVORY COAST
TOGOLAND
ASHANTI
NORTHERN
WESTERN
CENTRAL
SOUTHERN
WESTERN FRONTIER
GOLD COAST
COOMASSIE
ACCRA
SEKONDI

MAP B.


UPPER SENEGAL AND NIGER
TOGOLAND
IVORY COAST
NORTHERN TERRITORIES
NORTH WESTERN DISTRICT
NORTH EASTERN DISTRICT
SOUTHERN DISTRICT
DAGARTI
MAMPRUSI
DAGOMBA
GONJA
KINTAMPO
TAMALE
YENDI
GAMBAGA
BOLE
KINTAMPO
Daboya
Salaga
Wa
Lorha
Tumu
Bawku
Zebilla
Yagaba
Walewale
Savelugu
Sambu
Bole
Longoro
Bonduku
Kpabia
Brumase
Local Route
Uninhabited Bush
Undulating Uninhabited Prairie
R. Black Volta
R. White Volta
11°
10°
9°
8°
3°
2°
1°
0°
I
II
III
IV
V
VI
VII
VIII
IX
X
XI
XII
XIII
XIV
XV
XVI
XVII
XVIII


MAP
OF THE
GOLD COAST, ASHANTI,
AND
NORTHERN TERRITORIES.
Illustrating despatch from the Governor of the Gold Coast, 5th December 1914, included in Vol. III, Investigators' Reports, Yellow Fever (West Africa) Commission.
REFERENCE
Railways completed (single)
Railways in progress
Well defined main roads
Other routes
Telegraph along roads
Telegraph Office
T.
Postal Telegraph Office
P.T.
Boundary International
Boundary Colonial
Boundary Provincial
Boundary District
Ruins
Falls, Rapids
Principal trade routes shown in Purple, thus
Subsidiary local or alternative routes, Green
IVORY COAST
TOGOLAND
NORTHERN
ASHANTI
WESTERN
CENTRAL
SOUTHERN
WESTERN FRONTIER
VOLTA RIVER
COLONY
GOLD COAST
KWITTA
BIRRIM
AKIM ABUAKWA
SALTPOND
CAPE COAST
WINNEBA
ACCRA
TARKWA
AXIM
COOMASSIE
SEKONDI
ACCRA
Cape Three Points
BINGERVILLE
7°
6°
5°
4°
3°
2°
1°
0°
1°

[*Enclosure.*]

TRADE ROUTES LEADING INTO THE GOLD COAST COLONY.

Point of Entry.	From / To.	To / From.	Route	Volume.	Season.	Trade, 1913.
1	Moshi Country and Basin of Niger		Bawku, Gambaga, Karaga	Large ...	Dry ...	*Imports* :—Value £37,093. Principally cattle, sheep, horses, donkeys and country cloths and a little hardware, cotton, palm oil and native foodstuffs.
		(*a*) Kintampo and Coomassie	Tamale, Yapei			*Exports* :—Kola, 117,990 lbs.; salt, 560 lbs.; figures for other exports not available.
		(*b*) Coomassie and Cocoa District	Kpabia, Salaga			*Above combined with* 2.
2	Lome ...	Bawku ...	By rail to Agome, thence to Sansanne Mungu	Not large ...	Dry ...	*Combined with* 1.
3	Lome ...	Locally in N.T.	By rail to Agome, thence to Yendi	Small ...	Dry ...	*Value of imports*:—£706. Principally cloth and beads. *Exports* :—Negligible. Kola and salt.
4	North of Togoland	Coomassie ...	Yendi, Sambu, Kpabia, Salaga	Large ...	Dry ... Dec.—Apr. Apr.—Aug.	*Imports* :—Value £1,399. Principally sheep, goats, shea butter and leather goods. *Exports* :—Kola, 671,310 lbs.; salt, 16,180 lbs.; other exports trifling.
5	Yendi ...	Locally in N.T.	Kadenge ...	Small ...	Dry ...	*Imports* :—Value £847. Principally cloth and native produce. *Exports* :— Kola, 17,330 lbs.; salt, 1,064 lbs.; other exports trifling.

TRADE ROUTES LEADING INTO THE GOLD COAST COLONY—*continued.*

Point of Entry.	From / To	To / From	Route.	Volume.	Season.	Trade 1913.
6	Salaga and North	(*a*) Agome and Lome	Krupe ...	Large	Perennial...	*Imports* :—Value £1,674. Principally cotton and hardware.
		(*b*) Dodowa, Accra, Krobo Mts.	Krupi, Pajai, Krachi, Kpong		June & Dec. quarters	*Exports* :—2,038 cattle, 1,766 sheep. 2,218 cattle and 1,477 sheep passed southwards at Darcar Mouth.
7	Ashanti ...	(*a*) Agome and Togoland	British Kratchi	Entered 9,193, left 10,257 persons	Regular ...	*Imports* :—Value £401. Principally beads and cotton. *Exports* :—Ivory, 1,436 lbs.; kola, 3,823 lbs.; rubber, 2,375 lbs.; salt, 30,050 lbs.
	Northern Togoland	(*b*) Kwahu ...	British Kratchi		—	For work on cocoa farms.
8	Togoland ...	Kwahu ...	Nkami ...	Entered 3,101, left 3,967 persons	Highest Jan. to Mar. and Sept.	Trade negligible.
9	Kwahu ... Ho and Pando Districts, Togoland	(*a*) ? ... ... (*b*) Alternative route to (10), not much used	Pesse	Entered 5,558, left 5,990 persons	Highest May to July	*At Br. Kpeve.* *Imports*:—£2,082. Principally cattle, sheep and goats. *Exports* :—£10,075. Principally wearing apparel and specie.
10	Togoland and French Territory	Cocoa and Coast Towns	Frankadua to Senkye or Akuse	At *Senkye* :—Entered 43,527, left 29,804 persons	Highest Oct. and Nov.	*At Senkye.* *Imports.*—11,196 cattle, 16,807 sheep and goats.
					Jan. to Mar.	*At Frankadua.* *Imports* :—Value £21,074. Principally sheep and goats. *Exports* :—Value £44,223. Principally specie and wearing apparel.

11	Togoland ...	Cocoa and Coast Towns	Abutia and Adidome	Small ...	Perennial ...	Native cloths and sheep; trifling; local.
12	Togoland ...	Cocoa and Coast Towns	Avege and Adidome	Small ...	Perennial ...	Goats, fowls and sometimes cattle; trifling; local.
13	Togoland ...	Cocoa and Coast Towns	Kpeve and Adidome	—	Perennial ...	*Imports*:—Value £2,403. Principally foodstuffs and mats. *Exports*:— Value £1,646. Principally dried fish.
14	Togoland ...	Cocoa and Coast Towns	Deodze, Dabala, Teji	—	Perennial ...	*Imports*:—Value £3,211. Principally sheep, goats and general goods. *Exports*:— Value £4,689. Principally dried fish.
15	Lome ...	Cocoa and Coast Towns	Kwitta by land to Attititi by land or Kwitta Lagoon	—	Perennial ...	*Imports*:—Value £18,539. General goods. *Exports*:—Value £16,115. Principally dried fish.
16	Assinie ...	Half Assinie ...	Beach ...	Principal route	Perennial ...	*Imports*:—Large in dried fish; also beads, pomades and cloths. *Exports*:—Rubber.
17	Assinie ... Aboisso ...	(*a*) Half Assinie (*b*) Half Assinie	Lagoons ...	Principal route	Perennial ...	(*a*) as 16. (*b*) Cloths, pomades, perfumes.
18	Dissou ...	(*a*) Jema ... (*b*) Boinso ...	*viâ* B.P. 52 ... *viâ* B.P. 51.	Small ...	Perennial ...	Seldom used except by timber cutters.
18	Aboisso ...	(*c*) Sanom ...	Ebakro ...	Infinitesimal	Perennial ...	Petty in perfumes, cloths, haberdashery. Almost solely confined to natives of the Colony, who go to Aboisso to purchase goods for retail locally.
19	Aboisso ...	Anchi ...	Dibi-Yakase ...	Infinitesimal	Perennial ...	
20	Aboisso ...	(*a*) Kobina Krom (*b*) Amoya ... (*c*) Krokosua...	Akeykro and Dadiaso ? ?	Infinitesimal	Perennial ...	
21	Aboisso ...	Debiso ...	?	Infinitesimal	Perennial ...	

THE GOVERNOR TO THE SECRETARY OF STATE.

(Received 28th December, 1914.)

Government House, Accra,
5th December, 1914.

SIR,

I have the honour to forward herewith, reports from the Chief Commissioner of Ashanti and the Chief Commissioner of the Northern Territories, relating to the trade routes leading into those Dependencies, together with tabulated statements in duplicate, in which is embodied all the information at my disposal on the subject. I also enclose one copy of the $\frac{1}{1,000,000}$ map,* on which the routes in question have been marked. The numbers given in the first column of the statements correspond with the numbers marked against the trade routes shown on the map.

I have, &c.,
HUGH CLIFFORD,
Governor.

[*Enclosure* 1.]

Chief Commissioner's Office, Coomassie, Ashanti,
5th October, 1914.

SIR,

In reply to your letter of the 16th June last, I have the honour to forward a report on the principal trade-routes into Ashanti.

I have, &c.,
F. C. FULLER,
Chief Commissioner, Ashanti.

REPORT ON PRINCIPAL TRADE ROUTES COMING INTO ASHANTI.

On the western frontier of the Northern Province of Ashanti there appear to be no defined routes.

There are numerous small paths crossing the frontier. The trade consists of farm produce grown in Banda territory.

In the Western Province there are three main routes :—

No. 1 *W.*, through Bonduku from Kong and Haut Senegal et Niger, enters near Sikasiko. Trade : chiefly cattle, hide and kola, and some native cloths.

No. 2 *W.*, a continuation of route No. 1 W. from Bonduku, enters Ashanti near Goresua and joins No 1. (branch 3) at Pulliano. Trade : cattle and rubber.

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* Map B of the Gold Coast, etc.

No. 3 *W.*, from the southern and central portions of Ivory Coast, enters near Pamo, thence to Berekum, where it joins route 1 (branch 2). Trade: rubber.

The last two routes are little used since the fall in price of rubber. When the Bibiani Goldfields were working there was another route from Pulliano, through Pamo and Kukuom and Bibianaha; should they re-open this route would become important.

In addition, there are numerous small paths between villages.

FROM TOGOLAND.

There are no trade routes from the above territory; small local traffic exists between villages across the river.

All the remaining trade roads lead to and come from the Northern Territories, which Dependency will, no doubt, furnish a separate report.

[*Enclosure* 2.]

Chief Commissioner's Office, Tamale,
28th September, 1914.

I have the honour to transmit, under separate cover, a map with the principal trade routes entering this Protectorate from the surrounding foreign territories shown thereon.

I transmit, herewith, a report on these trade routes tabulated as requested. The routes, as will be seen, are somewhat complicated, for the main roads throw off many branches, which sometimes join other main routes. These are evidently used to avoid congestion in the cattle traffic, and, at certain times of year, to obtain better pasturage and water than are to be found on the main routes.

While recognizing that the use of so many roads by traders entering the Northern Territories increases considerably the chances of infection and the spread of disease, it appears to me that, until the Government is prepared to provide, at the various halting places, adequate water and possibly food supplies, for the use of traders and live stock passing up and down the country, it cannot well restrict them to the use of certain routes—a course which would minimize the risk of infection of local natives and of their cattle.

It may be of interest to record my experience that the mosquitoes *Stegomyia fasciata* and *Anopheles costalis* are to be found throughout the Protectorate.

During my recent tour I caught specimens of both at Lorha, and during this month in my house at Tamale. The "tsetse" fly is found everywhere in the vicinity of the large rivers.

I attach for convenience an extract—"Imports and Exports"—from my Annual Report on this Protectorate for 1913,* to be read with the report on trade routes.

C. H. Armitage,
Chief Commissioner, Northern Territories.

Imports and Exports.

As stated in previous reports on this Dependency, it is impossible, under present conditions, to give more than an approximate estimate of the volume of trade entering and leaving the country. Trade statistics are kept at stations situated on the main trade routes, but, as the registration of live stock and trade goods is voluntary, and as many caravans, especially those composed of live stock, pass through the stations during the night, the figures given can be looked on only as an indication of a general increase or decrease in trade, as the case may be. The trade route from the north through Daboya to Kintampo, and others of minor importance, do not pass through any stations where statistics can be collected, nor are such compiled at Kintampo in Ashanti. Imports consist generally of cotton and woollen goods, silk handkerchiefs and lengths, hardware, haberdashery, beads, brass rods, tobacco, tinned provisions, and kola nuts from Ashanti.

With the exception of the North-Western Province, where a distinct decrease in the caravan trade in cattle and moshi cloth is reported, the import and export trade has increased greatly during the year under review ; and it may be noted that the falling off in the North-Western Province is more than compensated for by the largely increased volume of trade that passes through the North-Eastern Province, particulars of which will be given later. This increase is directly due to the subjugation in 1911 of the wild tribes which held the Tong Hills as their stronghold and terrorised the surrounding country.

A broad road now runs through Tinzugu and Winduri in the heart of the Tong Hills, and this route is becoming most popular with the French traders.

The figures available show a total of 310,699 loads registered during the year, as against 229,750⅛ registered in 1912 : an increase of 80,948½ loads. The principal increases appear under the following heads :—

Cattle 40,346, sheep 40,345, donkeys 9,087, shea-butter 5,855½, dawa-dawa 2,128, and native blankets 1,837, while

* [Cd. 7050/47], 19th August, 1914.

decreases occur under "miscellaneous" 17,938½, cloth 8,886½, donkey loads (miscellaneous) 7,810, and donkey loads (shea-butter) 1,856.

The large increases in live stock are due to the failure of the crops and to lack of water in the area of Upper Senegal lying between Wagadugu and Timbuctoo, but, when the railway line now in course of construction from Dakar taps that country, we must expect a diversion of the trade, and a heavy fall in the number of animals passing through this Dependency to Ashanti and the Colony. In view of the fact that no transport facilities, beyond the excellent main roads, are available for the natives, and that no provision for such is contemplated, it is encouraging to note the increase under the heads of "shea-butter," "dawa-dawa," and "native blankets," for it demonstrates that the natives are realizing that money is to be made by the exploitation of these local industries.

In referring in my Annual Report for 1912 to alleged decrease of 24,188 loads under the heading "donkey loads, miscellaneous" as compared with the figures recorded under that head for 1911, I wrote as follows:—

> "I believe that donkey transport is, if anything, on the increase, and that the figures available are quite misleading. These are only quoted for comparison with those contained in the Annual Report on Ashanti."

These remarks apply equally this year.

During the year kola nuts and salt were exported over the inland frontiers through the southern preventive stations established on the eastern boundary of the Dependency as follows:—

Destination.	Kola (lbs.)	Salt (loads).
British	594,180	56
French	219,691	560
German	150,086	17,668
Total	963,957	18,284

The above figures were supplied by officers of the Preventive Service.

Fish, caught in the Volta River and sun dried, are exported to Ashanti and the coast, but this industry is in the hands of the

Bator tribe, who come up the river and encamp on its banks during the fishing season.

The Commissioner of the Southern Province reports as follows :—

" From the trade statistics furnished by the Commissioners there appears to be a considerable increase in the number of cattle, sheep and donkeys passing south to Ashanti.

" The District Commissioner, Salaga, reports that there has been a considerable drop in the number of loads of kola nuts, which he considers is due to the large quantities that are now being shipped by sea to Southern Nigeria. There has been a very slight increase in the kola trade passing through Tamale, whilst the returns from Bole show that the kola trade has been much the same as the previous year.

" There is a steady rise throughout the Province in the export of shea-butter and also in dawa-dawa. There is also throughout the Province a large increase in the number of loads of salt passing through.

" With regard to the imports of cloth from the Colony and Ashanti, there has been an increase, as also in loads of miscellaneous goods, with the exception of Salaga.

" There has been a decrease in goods imported from Togoland. The turnover in Messrs. Paul Hutter and Company's store at Tamale shows a decrease of £284 11s. 2½d. compared with 1912. The clerk in charge of the store is unable to furnish me with an explanation as to this decrease.

" Tamale port continues to increase in importance ; several new compounds have been built during the year, and applications for additional sites have been made.

" The District Commissioner, Bole, reports that trade has increased, but, during the rains, which were very heavy, and owing to the main roads being under water, a good deal of the trade passed through Busunu and Bonfu."

The Commissioner of the North-Western Province states :—

" The local trade, which is more or less a minor quantity, is much the same as it was a year ago.

" The caravan trade, however, shows a distinct falling off in cattle and moshi cloth. The sheep have increased by 10 per cent. over last year, but still show a very large decrease when compared with 1911. Other items do not call for comment.

" I am informed that one reason for the decrease in cattle is that the season has not been propitious in the French country,

where 95 per cent. of the cattle, etc., come from. Another reason given is that many chiefs have complained to the authorities of the increased migration, or rather desire to find work, or trade, amongst their people, and the authorities have tried to put pressure on the people. The chiefs wish it stopped as they cannot get the young men to farm.

"I have already reported on the number of French subjects passing through Wa empty-handed, the causes of which are conscription and the bad season.

"I am also of opinion that other roads are being used by the traders, and this can be verified if statistics from Kintampo were available.

"There is also no doubt that the enforcement of quarantine regulations by the French has had some effect."

The report of the Commissioner of the North-Eastern Province demonstrates that the decrease in volume of the caravan trade passing through the North-Western Province is due to the popularity of the recently opened trade routes through the Tong Hills. He states :—

"Trade statistics for the year are attached, and although they cannot be regarded as representing accurately the whole volume of the trade which passes through the Province, they do, however, clearly indicate that there has been a marked increase over the previous year.

"The following are the principal increases :—

Horse	121
Cattle	15,450
Sheep	15,458
Donkey	1,021
Donkey load	2,840
Carrier loads	23,622
Total ...	58,512

"It is to be regretted that this volume of trade does not materially benefit the Administration of the Protectorate, although it must add very considerably to the prosperity of the merchants of Ashanti and the Colony.

"Had the caravan tax still been in force the revenue of this Province, derived from this source alone, would have amounted to £13,244.

"It is impossible to value the whole of the trade, but that of the live stock imported during the year would approximately amount to £268,605, made up as follows :—

		£	s.	d.
653 horses at £6	... ...	3,918	0	0
43,943 cattle at £5	... ...	219,715	0	0
60,752 sheep at 12s.	... ...	36,451	4	0
5,682 donkeys at 30s.	... ...	8,521	0	0
Total	...	£268,605	4	0

"The following are the total increases at the various stations :—

	1912.	1913.	Increases.	Decreases.
Navarro	43,620	59,139	15,519	—
Gambaga	5,533	8,492	2,959	—
Bawku	39,674	63,320	23,646	—
Zouaragu	8,320	24,708	16,388	—
Total	97,147	155,659	58,512	—

"The most gratifying feature from an administrative point of view is the increase of 16,388 in the Zouaragu return, which proves conclusively the entire pacification of the district. Traders now come to Zouaragu from Bawku, and all the towns along the frontier, chiefly from Zoko on the north-east of the district, which is situated on a route which is rapidly becoming popular with French traders. They then travel south on the road which passes through Tonzugu and Winduri in the heart of the Tong Hills. Prior to the establishment of the station in 1910 no traders dare wander about the district, and, except for the exchange of foodstuffs at the local markets, which were constantly raided, there was no trade of any sort.

"There has been a very severe drought in the regions between Wagadugu and Timbuctoo, and to this fact may be attributed the increase in the live stock which has been, and still is, passing to Coomassie. The crops there have failed entirely, and neither food nor water can be obtained for the animals, and consequently the owners are getting rid of their stocks as quickly as possible, so probably next year there will be a decrease.

" The bulk of the trade is in the hands of Hausas, Moshis, and other non-British subjects, who sell their wares for cash, and thus denude the Province. But signs are to be observed that our own people are commencing to take an interest in external trade, and now go so far as Yagiba and Daboya, where they exchange sheep for salt, fish, cloth, etc.

" Efforts have been made to establish a trade in bees-wax and hides, but the result has not been very encouraging. The former is prepared in small quantities everywhere, but, until traders come up and prove to the people that a demand does exist, I fear it will not be any great success. As for hides, although in nearly every compound there are a few cattle, they are never killed for consumption, but kept chiefly for the purpose of paying headmoney on women."

TABLE OF PRINCIPAL TRADE ROUTES ENTERING THE NORTHERN TERRITORIES FROM THE IVORY COAST AND UPPER SENEGAL AND NIGER AND FROM TOGOLAND.

Number of Trade Route.	Description of Route.	Volume and Nature of Trade.	Periods when used by Traders.	Remarks.
I.	From Buna. Enters the Southern Province at the ford of Vonkoro on the Black Volta River, and passes (*a*) *viâ* Sawla (Sowala) and Larabanga to Yapei and Tamale Port, and (*b*) to Bole, where it joins Trade Route No. II.	(*a*) Chiefly cattle, shea-butter and small quantities of gold dust in exchange for salt.	From December to July ...	A track also runs from Buna to Tantama, where there is a ferry; thence to Komforhosi, and joins Route II. at Nakpala (marked green on map). "Shea-butter." A vegetable fat procured from the kernel of the fruit of the tree *Butyrospermum parkii.*
II.	From San in the Valley of the Niger, Segon and Bamako *viâ* Bobo, Dionlassu and Diebugu. Enters the North-Western Province at Manoa near Lorha. The route to Wa is (*a*) *viâ* Babile, Iziri, Tansia, Nator and Cherra; (*b*) by Babile, Iziri and Sombo; (*c*) when the country is flooded the Girapa route is used occasionally (marked green). The road then passes *viâ* Kulmasa, Nakwabi and (*a*) Nakpala, (*b*) Swala to Wankuma and Bole, whence it goes south *viâ* Suripe, Wasipe, Banda N'kwanta and Jugbe. The main road proceeds *viâ* Bampewa, crossing the Black Volta River at the Buere ford and on to Kintampo and Coomassie. Another road from Jugbe—and that most frequently used by traders—crosses the Black Volta at the Bamboi ford and passes *viâ* Wenchi to Coomassie.	Herds of up to 300 cattle come down *viâ* Lorha and Wa, each in charge of a few men, who return with gold and dollars, and but rarely with kola nuts or trade goods. The volume of the cattle trade from the north has increased greatly, 15,671 cattle passed through Bole from January to July this year; the average number being reckoned at 2,000 a month. The trade in shea-butter and dawa-dawa is reported from Bole to be brisk during the rains, with an average of 2,000 loads a month. In the Southern Province:—Southwards, cattle, sheep, fowls, hides, shea-butter, dawa-dawa for cash. Northwards, cloth, copper rods and kola nuts.	The trade passing along this route from Lorha usually dwindles after the end of May, but has not done so this year, either on account of the little rain that has fallen or of the famine said to be raging in the Upper Senegal and Niger Districts. The normal trade in cattle falls off at the commencement of the rains—July to December—owing to flooded rivers.	This route, so far as the Bole District is concerned, is by far the most important of the three routes traversing that district. "Dawa-dawa." A food prepared from the beans of the tree *Parkia filicoidea.* "Kola-nuts." The fruit or nut of the tree *Cola acuminata.* In great demand among the inhabitants of the Sudan, who chew it to allay hunger and thirst. There is a steel pontoon boat on the Black Volta at the Buere ford.

III.	This route enters the North-Western Province from Upper Senegal at (*a*) Hamela and (*b*) Namora; joins up at Ulu, and runs south *viâ* Boussie, Naro and Jang to Wa, where it joins Route II.	The trade is of a general description and there is a greater proportion of men to beasts travelling along this route, who return with loads—principally of kola nuts.	The natives trade during the dry season—December to July—and return to their country to prepare their farms when the rains commence.	Used by the Wongara and Moshi natives from Boromo and adjacent villages.
IV.	Enters the North-Western Province north of Golu and runs in a south-westerly direction to Nandaw, where it joins Route III. at (*a*) Ulu and (*b*) Bonssie.	The trade is of a general description, and there is a greater proportion of men to beasts travelling along this route, who return with loads—principally of kola nuts.	The natives trade during the dry season—December to July—and return to their country to prepare their farms when the rains commence.	Used by the natives of Sette in French Grunshi.
V.	This main trade route (cleared twenty feet, and partly ditched) enters the North-Western Province at Lingemera from Leo, and, passing through Tumu and Walembele, joins up with Route II. at Wa.	Until recently this route bore the bulk of the trade passing through the North-Western Province, but Route II. now takes the greater number of cattle. The southward-bound trade is usually in cattle, sheep and goats, while large numbers of donkeys are brought down, and return loaded with kola nuts and cloth. Many head loads of shea-butter, dawadawa, and native blankets are carried down this route.	During the dry season steady streams of natives pass up and down this route; the former returning to make their farms, the latter to trade or find employment in Ashanti.	This route is used principally by Moshis, but natives from beyond Onagandongou, from Timbuctoo, Arabs, and, more rarely, travellers from Morocco, are to be met. There are two rivers at Wahabu and Menyon on this route which are unfordable after every rains, as they rise very quickly.
VI.	Branches off from Route V. at Tumu and runs in a south-easterly direction *viâ* Santigan to Yagaba, where it joins Route VII.	Used by small parties only, taking cattle, sheep and donkeys south, and returning with salt from Daboya.	Used during the dry season.	This route is patronized by both British and French Grunshis, and may be said to commence at Dolbezan, where traders arrive by the many tracks that converge on that village.

TABLE OF PRINCIPAL TRADE ROUTES—*continued.*

Number of Trade Route.	Description of Route.	Volume and Nature of Trade.	Periods when used by Traders.	Remarks.
VII.	This route enters the North-Eastern Province from Onagondongou, in French Upper Senegal, at Paha (Paga), and, passing through the villages of Chuchulliga and Kanjarga, crosses the ferries on the Sissilli and Kulpawn Rivers to Yagaba, where Route VI. meets it. It then proceeds south to Daboya, and thence *viâ* Busunu and Buipe to the ford on the Black Volta River at Gerinyatto, and on through Porta to Kintampo and Coomassie.	The trade, which is considerable, consists chiefly in cattle and sheep to the south, and in kola nuts and salt to the north.	This route is used throughout the year, subject to the "seeding-time," *i.e.*, the time for preparing the farms, when, it is stated, the French keep the natives from trading until the farms have been planted.	Used by the Moshi traders.
VIII.	This route also enters the Protectorate at Paha (Paga), but branches off from there to Navarro, the headquarters of the North-Eastern Province, and thence through Korogu to Naga, where a road branches off to the south-west through Kunkwor to Yagaba, there forming a juncture with Route VII. (This road marked green.) The main road continues through Dua, Wale-Wale, Nasia, Savelugu, Tamale, Dogankade, Masaka, Salaga, Yeji, and Prang, *viâ* Attabubu and Ejura, to Coomassie. The following subsidiary trade routes are thrown out from the main road, and are marked in green on the map :— (i) From Pong Tamale to the south-west *viâ* Kumbungu to Tamale Port (Yapei).	This route is popular, as Navarro (the headquarters of the North-Eastern Province) is felt to be a safe resting place, and, in consequence, the Government caravanserai is usually crowded. Trade consists chiefly in cattle, sheep, and Moshi cloth southwards, and in kola nuts and salt northwards. In the Southern Province the southern trade is in cattle, sheep, goats, shea-butter, dawa-dawa, native cloth, and, locally, foodstuffs for cash, and, northwards, kola nuts, brass and copper rods and cloth.	Very large caravans travel by night down the Government road from Navarro to Naga, and, in the dry weather, follow the route to Yagaba, and so on down Route VII. The main road to Tamale is both a dry and wet weather route. The remarks made above with regard to "seeding-time" apply also to this route.	There is a steel pontoon boat on the ferry at the White Volta River between Naga and Dua, and half-sections on the river at Nasia and Nabogo. Two pontoon boats are on the Volta River at the Government ferry at Yeji. Tamale Port (Yapei); this is the great salt depôt for the Northern Territories. The salt is brought up in bags from Addah and Akuse *viâ* the Volta River. *Note.*—The French Moshis are to be found scattered all over the country in the North-Eastern Province at certain times of the year, and are encountered on the most remote by-paths searching

	(ii) From Tamale *viâ* Sangrawla to Tamale Port. (iii) To the south-east from Savelugu, joining Route XI. at Palbe. (iv) From Tamale, joining Route III. at Yamalaga. (v) To the south-west from Masaka, *viâ* Kakosi, and crossing the Katakunji Ferry to Yeji. (vi) From Salaga *viâ* Krupi to Dakar River mouth, and on to British Kratchie. (vii) From Yeji along the left bank of the River Pru to Prang. A road branches off from route. (viii) Between Naga and Dua ferry, and runs in a south-westerly direction to Yagaba, where it joins Route VII. (marked green on the map).			for food which they are not able to find in their own country. It is not unlikely that they are, but too often, the bearers of infectious diseases.
IX.	Enters the Protectorate north of Boku and passes south through Bolgatanga, Tong, Paragu, and Wulugu to Wale-Wale, where it joins the main trade Route VIII. Branch roads run from Bolgatanga (*a*) *viâ* Serigu (Shirigu) to Naga, and (*b*) *viâ* Balunge (Belungu) direct to the Naga ferry, where they join Route VIII.	This route, until recently of no importance, has become popular since it was opened after the subjugation of the Tong Hill marauders (*vide* "Northern Territories Annual Report" for 1913, Imports and Exports). Trade to the south: cattle, sheep, and shea-butter; to the north: kola nuts and salt.	Route IX. is described as the "wet weather route": its branches (*a*) and (*b*) as the "dry weather routes."	French native subjects from across the border trade locally in sheep and foodstuffs with the natives of Bongo (where there is a big market), Bolgatanga and Zouaragu (the headquarters of the Northern Territories Company of the Gold Coast Regiment). There is a section of a steel pontoon boat at the Paragu ferry.
X.	The route enters the Protectorate north of Arabe, and, tapping the Kulmasa Market, passes south to Zouaragu.	Of local importance only. Sheep are brought down and the traders return with salt. The chief trade is said to be in "soki," *i.e.*, Guinea corn prepared in a certain way for the making of "peto," native beer.	Used throughout the year.	The Native traders come from French Busanga country, where the "soki" is prepared.

Table of Principal Trade Routes—*continued.*

Number of Trade Route.	Description of Route.	Volume and Nature of Trade.	Periods when used by Traders.	Remarks.
XI.	From Tenkudogo and Fada N'Gurma in French territory, this route enters the Protectorate north of Bawku and divides at Kugri; the western route passing *viâ* Zongoire to Gambaga; the eastern, south through Sinebagga to Gambaga. The main route then runs south through Timboro and Suguri to Karaga, where it bifurcates and runs (*a*) south and west *viâ* Ga, Jimle and Palbe to Turu, and (*b*) south and *viâ* Patenga, Zan, Kpabia and Zankum to Turu; then on to Dogankade where it merges into Route VIII. [(*b*) is known as "the old military road"]. This route is also linked up with Route VIII. by the Government road running south-west from Gambaga *viâ* Maibindiga and Paragu to Nasia. At Maibindiga a road (formerly a main trade route) passes through Wale-Wale and Wungu, and, crossing the White Volta at Wiema ferry, proceeds to join Route VII. at Yagaba. It is but seldom used to-day. (Marked green on the map.)	A large trade in cattle, sheep and Moshi cloth pours south along this route. A number of horses are also taken down, the traders returning with kola nuts and salt. In the Southern Province cattle, sheep, goats, horses, shea-butter, dawa-dawa and a small amount of foodstuffs pass down, while kola nuts, salt, brass and copper rods and cloth pass north. (*Vide* "Northern Territories Annual Report for 1913." "Imports and Exports.")	The cattle trade in the North-Eastern Province is stated to be very regular throughout the year, falling off to a certain extent during the heavy rains, when great difficulty is experienced in crossing the swollen rivers. This, however, has its compensations in the shape of abundant grass and water supplies, and the cattle brought down during the rains are in a much healthier condition than those driven down during the dry season. The "old military road" suffers in the dry season from want of water, and in the wet from the Gonyiri Swamp, the worst in the Protectorate, which has to be crossed. In the Southern Province the majority of the cattle and sheep pass through Tamale during the first six months of the year.	In order to avoid the ascent of the steep scarp north of Gambaga, a certain number of cattle are taken by the road (marked red on the map), *viâ* Gogo or Binduri, Tili and Nangudi to Zouaragu, whence they are driven south along Route IX., or, in the dry season, *viâ* Naga and Yagaba. Large numbers of Bazaberimis, Kotokolis and Moshis pass down from the north annually during the months of December and January to find work in Ashanti and the Colony. Some return in a few months, others stay away from their country for some years.
XII.	From Sansanne-Mangu. Enters the North-Eastern Province east of Malerigu and on to Gambaga.	Local trade in cloth, brass rods and other goods of European manufacture, chiefly German.	Throughout the year except at "seeding-time."	—

XIII.	From Yendi. Passes through the Bongo market to Gambaga.	As above.	As above.	—
XIV.	From Sansanne Mangu-Kotokoli. Enters the Southern Province at Patenga and then runs in a south-westerly direction *viâ* Garimo, Sihun and Tamale to Tamale Port.	Soap, mats, palm-oil and native (dzugu) cloth. Traders return with kola nuts and salt for cash.	As above.	—
XV.	From Yendi. Enters the Southern Province at Ga and joins Route XI. at Kpabia (Preventive Station).	As above. Traders return with kola nuts and mixed goods for cash.	As above.	—
XVI.	From Jonayile. Enters the Southern Province at Kadenge (Preventive Station), in the Salaga District, and joins the main route (No. XI.) at Dogankade (Preventive Station).	A local trade in soap, mats and foodstuffs.	As above.	—
XVII.	From Bimbila. Enters the Southern Province at Kunkwa (Preventive Station), and joins the main route (VIII.) at Salaga.	Soap, mats and foodstuffs. Kola nuts and general goods for cash.	As above.	—
Local Route	This route, marked green on the map, runs from Wa *viâ* Bulengu (Bullenga), Dusi and Jinfronu to Daboya.	Traders proceed from Wa to Daboya to purchase salt; cattle and donkeys are met on the road, but not in large numbers.	Used throughout the year, except during periods of heavy rains and floods.	Used by traders from Dagarti and French Lobi, and who, on returning, generally leave the main road at Bulengu, and proceed to their villages by the nearest "bush tracks."

Tamale,
28th September, 1914.

C. H. Armitage,
Chief Commissioner of the Northern Territories.

[*Enclosure* 3.]

TABLE OF PRINCIPAL TRADE ROUTES ENTERING ASHANTI FROM THE IVORY COAST AND TOGOLAND.

Number of Trade Route.	Description of Route.	Volume and Nature of Trade.	Remarks.
XVIII.	From Hong and Hant through Bonduku, entering the Western Province of Ashanti at Sikasiko, and thence by Nkoransa to Coomassie. Another branch from Sikasiko joins Route XIX. at Puliano.	Chiefly cattle, hides and kola; some native cloths.	—
XIX.	Another route from Bonduku, entering Ashanti near Goresua, thence to Puliano and from Puliano *viâ* Berekum and Odumase to Coomassie.	—	Little used since fall in price of rubber.
XX.	From the southern and central portion of the Ivory Coast, entering Ashanti near Pamo and joining Route XIX. at Berekum.	—	Little used since fall in price of rubber.

YELLOW FEVER COMMISSION (WEST AFRICA).

CORRESPONDENCE RELATING TO THE INTRODUCTION OF INFECTION INTO THE WEST AFRICAN COLONIES BY SEA.

THE SECRETARY OF STATE TO THE GOVERNORS OF THE BRITISH DEPENDENCIES IN WEST AFRICA.

Downing Street,
16th December, 1913.

SIR,

I have the honour to inform you that the Yellow Fever (West Africa) Commission are anxious to have reliable information in regard to the conditions of the sea-borne traffic of the West African ports, with special reference to the circumstances favouring the introduction of Yellow Fever by this means.

They would, therefore, be glad if from time to time, as occasion serves, the port health authorities would make a careful examination of vessels of every class trading with the ports within your administration, with a view especially to determining the presence and, when present, the degree of prevalence of the *Stegomyia* mosquito on board, both in the larval and in the adult stage. The enquiry need not be exhaustive ; opportunities for the examination would, presumably, be furnished by the ordinary routine of the official duties of the investigating officers ; and they would be best able to determine how many vessels of each kind (from the mail steamer to the canoe) would furnish a satisfactory estimate of the general condition of the shipping of the class. They would, of course, at the same time, note any other features of the traffic likely to have a bearing on the question.

I have, &c.,

L. HARCOURT.

GAMBIA.

THE GOVERNOR TO THE SECRETARY OF STATE.

(Received 10th July, 1914.)

Government House, Bathurst, Gambia,
20th June, 1914.

SIR,

I have the honour to enclose a report submitted by the Senior Medical Officer, on the question of the prevalence of the *Stegomyia* mosquito on board vessels trading with this port.

It is possible that more definite information on the subject may be obtainable hereafter through the Customs Department, and I will refer the question to the Receiver-General.

I have, &c.,

EDWARD J. CAMERON,
Governor and Commander-in-Chief.

[*Enclosure.*]

Medical Office, Bathurst, Gambia,
(No. 195.) *17th June*, 1914.

SIR,

I have the honour to report that investigations made during the last six months as to the presence of larvæ or adult *Stegomyia* on boats trading in the ports of the Gambia have been confined to those cases where it has been requisite for the Medical Officer of Health to visit and inspect such ships.

The examinations made on such occasions have included steamers and sailing boats, but have never discovered the presence of larvæ or adult *Stegomyia*.

On inquiry, the officers of steamers have in some cases stated that there are a few mosquitoes on board, but I have not been able to obtain specimens for identification.

I have, &c.,

A. E. HORN,
Senior Medical Officer.

THE GOVERNOR TO THE SECRETARY OF STATE.

(Received 19th December, 1914.)

Government House, Bathurst, Gambia,

28th November, 1914.

SIR,

I have the honour to enclose copy of a report to the Receiver-General by the Boarding Officer of the port, on the subject of the prevalence of the *Stegomyia* mosquito on vessels trading with Bathurst, together with copy of a minute from the Senior Medical Officer commenting on the same.

I have, &c.,

EDWARD J. CAMERON,

Governor and Commander-in-Chief.

[*Enclosure* 1.]

Attached is list of vessels inspected by me. The result of my inspection showed a total absence of mosquitoes in the larval or adult stage. The only reason for this was—according to my belief and that of several ships' officers whom I have interviewed on the subject—that any mosquitoes which might have been carried from the last port of call were completely flown away at sea before the ship's arrival at next port.

It was only on one solitary occasion that I discovered some mosquitoes on the "Muraji," which arrived and remained outside on the night of 15th July and entered the harbour on the following morning. I enquired about this from the purser, who reported that there were no mosquitoes on board when the ship dropped anchor on night of 15th, and that it was about 2 o'clock in the morning that the presence of mosquitoes from Bathurst was felt on board.

No inspection was made of ships in quarantine, but the masters of these vessels in every case reported total absence of mosquitoes.

S. F. LEIGH.

20th November, 1914.

List of Vessels Inspected.

Name of Vessel.	Where from.	When arrived.	Remarks.
Muraji, s.s.	Liverpool ...	16 July, 1914 ...	—
Obuasi, s.s.	London ...	17 ,, ...	—
Eloby, s.s, ...	Sierra Leone	18 ,, ..	—
Henriette Woermann, s.	Hamburg ..	22 ,, ..	—
Rufisque, cutter .	Foundiougne	22 ,, ...	—
Selika, s.s.	,,	23 ,, ...	—
Prahsu, s.s.	Sierra Leone	26 ,, ..	—
Ansonia, s.s.	Marseilles ..	27 ,, ...	In quarantine.
Tibet, s.s.	,,	28 ,, ..	—
Liberia, s.s.	Conakry ...	28 ,, ...	—
Addah, s.s.	Liverpool ...	29 ,, .	—
Bathurst, s.s.	Hamburg ...	1 August, 1914 ...	—
Tendaba, s.s.	Dakar ...	4 ,, ..	In quarantine
Nigeria, s.s.	Sierra Leone	8 ,, ...	—
Sandu, s.s.	Rufisque ..	9 ,, ...	—
Rufisque, cutter ...	Foundiougne	9 ,, ..	—
Accra, s.s.	Liverpool ..	14 ,, ..	—
Ormidale, s.s.	London ...	15 ,, ..	—
Akabo, s.s.	Liverpool ...	20 ,, ...	—
Ecaterina Couppa, s.s....	Foundiougne	20 ,, ..	In quarantine.
Rufisque, cutter ...	,,	27 ,, ..	—
Eboe, s.s.	Liverpool ...	31 ,, ..	—
Prahsu, s.s.	,,	3 September, 1914	—
Dioudiou, motor boat ..	Foundiougne	4 ,, ..	—
Rufisque, cutter ...	,,	6 ,, ...	—
Appam, s.s.	Liverpool ...	10 ,, ...	Troopship; no inspection.
Tendaba, s.s.	Dakar ...	11 ,, ..	In quarantine.
Combo, s.s.	,,	11 ,, ...	,,
Akassa, s.s.	Liverpool ...	15 ,, ...	—
Rufisque, cutter ...	Foundiougne	21 ,,	—
Gando, s.s.	Liverpool ...	23 ,, ..	—
Sandu, s.s.	Dakar ...	23 ,, ..	—
Cromarty, s.s.	Rufisque ...	25 ,, ..	—
Addah, s.s.	Sierra Leone	25 ,, ...	—
Memnon, s.s.	Rotterdam...	27 ,, ..	—
Mungo Park, s.s. ...	Dakar ...	27 ,, ..	In quarantine.
Accra, s.s.	Sierra Leone	29 ,, ...	—
Ramatoulie Joof, cutter	Carabane ...	5 October, 1914 ..	—
Tamsir, cutter	Foundiougne	8 ,, ...	—
Rufisque, cutter ...	,,	8 ,, ...	—
Sandu, s.s.	Dakar ...	12 ,, ...	—
Aburi, s.s.	Liverpool ...	16 ,, ...	—
Stamboul, s.s.	Marseilles ...	16 ,, ...	—
Ayr, s.s.	Foundiougne	17 ,, ...	—
General Dodds, s.s. ...	Dakar ...	17 ,, ...	—
Agberi, s.s.	Sierra Leone	17 ,, ...	—

LIST OF VESSELS INSPECTED—*continued.*

Name of Vessel.	Where from.	When arrived.	Remarks.
Ebatoulie, cutter ...	Rufisque ..	25 October, 1914 ...	—
Louis, cutter	,,	26 ,, ...	—
Guetty, motor boat ..	Foundiougne	27 ,, ..	—
Cecil H. Lord, schooner	Maio ...	7 November, 1914	—
Diana, schooner ..	,,	7 ,, ...	—
Rufisque, cutter ...	Foundiougne	9 ,, ...	—
Patani, s.s.	Sierra Leone	10 ,, ...	—
Gergovia, s.s.	Marseilles ...	12 ,, ...	—
Elector, schooner ...	Maio ...	16 ,, ...	—
Gambia, schooner ..	,,	17 ,, ...	—

20th November, 1914. S. F. L.

[*Enclosure* 2.]

I would suggest that a copy of the foregoing report be forwarded to the Secretary of State. As these observations have now been conducted throughout the rainy reason and a great part of the dry season without any positive result, it does not appear probable that ships calling at Bathurst are likely to bring infected mosquitoes from other ports.

A. E. HORN.

27th November, 1914.

SIERRA LEONE.

THE GOVERNOR TO THE SECRETARY OF STATE.

9th December, 1913.

SIR,

I have the honour to transmit herewith a copy of a report by the Comptroller of Customs on the trade carried on between Sierra Leone and the neighbouring Colonies by means of native craft for the years 1910-1913.

The report has been obtained at the suggestion of the Principal Medical Officer, a copy of whose minute on the subject is enclosed.

I have, &c.,

E. EVELYN,

Deputy-Governor.

[*Enclosure* 1.]

The following table (*see* page 221) indicates the extent and direction of the trade carried on by means of native craft between Sierra Leone and the neighbouring Colonies.

2. It is evident that the trade conducted by means of native craft is not confined to Freetown and Sherbro. For this reason, although only these two ports are mentioned in your minute, I quote in addition figures for three sub-ports. The table furnishes a complete statement of the small craft trade of this Colony with its neighbours.

3. The great bulk of this class of trade is with the adjacent territory of French Guinea. It is of a very general character, though largely consisting of interchange of natural products. Imports from French Guinea are mainly goods of European manufacture ; exports thereto are local produce and general European goods, the former accounting for more than half the yearly value.

4. Much of the live stock imported into Sierra Leone is brought from French Guinea in the larger class of native craft, principally to Mahela, which port, as the table indicates, has by far the most intimate connection of any Sierra Leone port with any of the neighbouring Colonies.

5. Trade with Portuguese Guinea is very similar to that described above, Freetown being the only port which has oversea communication with that Colony.

6. Mano Salija, in the south of the Colony, and Gene, on the Mano River, provide convenient bases for trade with Liberia. Here, again, the small trade which is carried on is of a general nature, though the convenience of Mano Salija as a port of shipment induces Liberian farmers to send an appreciable quantity of produce to that port *viâ* British Gene.

7. In connection with the object of this report, it may be of useful interest to state that a ferry canoe crosses the Manoe River between Liberian Gene and British Gene some eight times daily, carrying passengers and goods. It is not easily possible to estimate the number of persons who use the ferry in the course of a year, but it is evident that a large number of people must enter the Protectorate of Sierra Leone by this route.

8. The transit trade on the Mano River does not affect Sierra Leone to any appreciable extent. It is not trade in the strict meaning of the term, consisting, as it does, of cargoes of general

Port.	1910.				1911.				1912.				1913.*			
	Craft trading to				Craft trading to				Craft trading to				Craft trading to			
	French Guinea.	Portuguese Guinea.	Liberia.	Men.	French Guinea.	Portuguese Guinea.	Liberia.	Men.	French Guinea.	Portuguese Guinea.	Liberia.	Men.	French Guinea.	Portuguese Guinea.	Liberia.	Men.
Freetown ...	54	4	—	781	34	5	—	585	36	2	—	356	28	2	—	341
Sherbro ...	—	—	—	—	2	—	—	46	1	—	—	22	—	—	—	—
Mahela ...	339	—	—	1,508	219	—	—	1,057	343	—	—	1,489	25	—	—	897
M. Salija ...	—	—	3	16	—	—	2	4	—	—	5	26	—	—	4	20
Gene ...	—	—	—	—	—	—	—	—	—	—	6	34	—	—	3	15

* Up to end of September.

goods—largely trade spirits—shipped from a Liberian port on the seaboard to another Liberian port on the river which forms the boundary between Liberia and Sierra Leone.

9. In the above table are included those sloops and cutters which trade regularly between Sierra Leone and neighbouring Colonies. This accounts for what may seem at first sight a number of men disproportionately large to the number of vessels engaged. These vessels trade to Freetown and Sherbro only. A further explanation of the large number of men engaged is furnished by the fact that it is usual for these small craft to carry hands sufficient to row or paddle in the event of the vessel being becalmed.

A. P. VIRET,

17th November, 1913. *Comptroller of Customs.*

[*Enclosure* 2.]

I happen to know that the information with regard to trade routes was originally asked for in connection with the controversy as to the origin of the outbreak of Yellow Fever at Freetown in 1910—the possible sources of infection being the point at issue.

I am given to understand that a considerable trade is carried on between Sierra Leone and other Colonies adjacent by means of native vessels, and I suggest that a report on this trade be called for from the Harbour Master and Comptroller of Customs, and the information forwarded to the Secretary of State in order that his knowledge of the subject may be as complete as possible.

T. E. RICE,

8th November, 1913. *Principal Medical Officer.*

THE GOVERNOR TO THE SECRETARY OF STATE.

Government House, Sierra Leone,

31st July, 1914.

SIR,

With reference to your despatch of the 16th December last, in which you asked that the port health authorities should be instructed to make a careful examination of vessels of every class trading with the ports of this Colony, with a view to determining the presence, and when present, the degree of prevalence of the *Stegomyia* mosquito on board, both at the larval and at the adult

stage, I have the honour to transmit herewith, for your information, two reports which have been furnished by the Senior Sanitary Officer, on :—

(*a*) Prevalence of mosquitoes on board ships calling at Freetown ; and

(*b*) Presence of mosquitoes on vessels other than steamers.

Investigation (*a*) was carried out during the dry season, and (*b*) during the wet season.

The investigations have been carried out in as thorough a manner as possible under the circumstances.

I have, &c.,

E. M. MEREWETHER,

Governor.

[*Enclosure* 1.]

PREVALENCE OF MOSQUITOES ON BOARD SHIPS CALLING AT FREETOWN, SIERRA LEONE.

This investigation was carried on from the 8th of April to the 24th of May, 1914. During that period twelve ships were boarded and examined. A tabulated list of the ships is appended.

The following are the names of the vessels with the name of the port from which it came, and the number of ports of call between that and Freetown :—

Name of Ship.	*Starting port.*	*Number of ports of call.*
s.s. "Elobi"	Forcados	11
s.s. "Lothai Bohlen"	Assinie	8
s.s. "Bassam"	Calabar	4
s.s. "Patani"	Freetown to Sherbro and back	1
s.s. "Gando"	Opobo	13
s.s. "Teneriffe"	Half Assinie	3
s.s. "Togo"	Cotonou	—
s.s. "Akassa"	Akassa	16
s.s. "Nembe"	Forcados	3
s.s. "Henrietta Woermann"	Assinie	11
s.s. "Warri"	Sapeli	13
s.s. "Boma"	Sapeli	12

Special attention was paid to examination of (1) forecastle, (2) cabins, (3) holds. In addition to searching for live specimens of mosquitoes all vessels containing water, fresh or salt, found on

board were examined for the presence of larvæ. Inquiries were also made regarding the occurrence of illness on board during the voyage, the nature, duration, and result of such illness, the diagnosis being confirmed, where possible, by the taking of blood films.

In most instances the parts of the vessels examined were gone over twice, the second occasion being made to cover the usual period of mosquito activity, viz., from six o'clock or thereabouts, onwards. Where the vessel remained only a short time in port, this of course could not be done. To carry out these investigations thoroughly, it was necessary to enlist the sympathies of both officers and crew, and in this I must say I was very fortunate, for on practically all of the vessels I had the active co-operation of all on board, so much so, indeed, that many new and strange "mosquitoes" were brought to me from time to time, including even our old friend "Daddy longlegs" in a slightly reduced size. I had also to attend one or two night calls in order to capture a mosquisto that someone had heard singing about his head. Thus where mosquitoes were unable to be found on board a vessel, I think it may fairly be taken as pretty certain that there were none on board.

Wherever in the tabulated list it appears that no holds were examined, it means that they were too full of cargo to admit of being entered.

A mosquito net was also taken on board each vessel for the purpose of setting "live baits," but no suitable occasion arose in which to make use of it.

Out of the twelve ships visited, mosquitoes were discovered in three only, namely, the s.s. "Patani," s.s "Henrietta Woermann," and s.s. "Warri."

With regard to the first of these, the s.s. "Patani," I made a special journey in her on 17th April, to Sherbro Island, which lies 90 odd miles along the Sierra Leone coast in a south-easterly direction. After a stay of about eighteen hours at Sherbro we returned to Freetown. On the journey to the island I had ample time to make a very thorough examination, and was able to convince myself that we had not a mosquito on board. After covering about two-thirds of the journey the Captain found it necessary to drop anchor, so we passed the night on the open sea out of sight of land. Up to a late hour that night I found no sign of mosquitoes and my own cabin was certainly quite free of them. Next day (18th April), about noon, we anchored in Sherbro River, *i.e.*, the strip of tidal water separating the island from the mainland. This water has only a very

narrow navigable channel, so that vessels anchored in it are of necessity close to the mangrove swamps lining the river side. The remainder of the 18th was spent in unloading cargo from the vessel, lighters being sent from the town of Bonthe on the island for that purpose.

That night mosquitoes were present on the vessel, and after some hunting I was able to capture six specimens ; three in the black crew's quarters, one in the white crew's, one in the lavatory, and one in my own cabin. The following day (19th April) we left Sherbro for Freetown, and as we did not arrive there till late at night I had time to go over the ship again, with the result that I obtained a further nine specimens from the following places : two from the dining saloon wall, three from the cabin of the second officer, three from that of the third officer, and one on the outside of my mosquito curtain early on the following morning. On this day (20th) I went on shore, but as the vessel was remaining in the harbour another day I returned and passed the night on board. The result of this night's search was : two from the white crew's quarters, three in the native quarters, one in the second officer's cabin, and three in my own cabin.

All the mosquitoes obtained were discovered in a great variety of places in the vessel ; for example, on the walls in dark corners, from the ceilings, amongst the folds of berth curtains and in the curtains over port holes, behind swing looking-glasses, under settees, and, in fact, wherever there was a dark or shaded place where they could hide. In the forecastle, where the lights were dimmer, some were caught on the wing whilst flying around the electric bulbs. For the purpose of searching the various dark corners, I used an electric bull's-eye lamp with powerful dry battery capable of giving a continuous light.

The two foreholds of this vessel were examined on both the outward and return journeys, but on neither occasion was I able to demonstrate the presence of mosquitoes.

In fact, no flying insects of any sort seemed to be present, whereas in the holds of all the other vessels examined, moths and a species of small flying beetle were always to be found, the shining of the light invariably bringing them out of their corners. Possibly the absence of these creatures on this particular boat might be accounted for by the nature of the cargo, which was composed mainly of tins of kerosene.

In all twenty-four mosquitoes were captured, and identification showed them to consist of the following :—*Culex decens* = 12, *Pyretophorus costalis* = 11, *Ochlerotatus* (? sp.) = 1.

Anophelines were, therefore, present to the extent of 50 per cent., and of the twelve, ten were females, the one specimen of *Ochlerotatus* being a male.

Of the *Culicines*, four were males and eight females. Both *Anophelines* and *Culicines* were obtained in equal numbers from the forecastle and also from the cabins.

As regards the arrival on board of these mosquitoes, there are two sources from which they might have come, viz., in the three empty lighters sent out from Bonthe to take off the cargo, or from the mangroves which lined the river and which were only about four hundred yards from the vessel. I think the latter seems the more likely source.

The next vessel, the "Henrietta Woermann," had just arrived from Sherbro Island when I visited her. She had passed two nights there, remaining eighteen hours altogether, and previous to calling there had been travelling up the coast from Assinie. At none of the other ports however, with the exception of Freetown, had the vessel been nearer the shore than half a mile, so that, in all probability, the mosquitoes got aboard at Sherbro. Both officers and crew said that they had hardly been troubled at all by them while anchored there, and a considerable searching of the forecastle was necessary, before I finally succeeded in dislodging one from the tuft (leaves) of a pineapple suspended from the edge of one of the bunks. Owing to the vessel only remaining a short time in Freetown harbour, I had no time to go through the other parts of the vessel except the cabin of the third engineer, who came to me saying that he had heard mosquitoes "singing" in his room. After some little searching we finally discovered two in the folds of the berth curtains. One I managed to capture, but the other escaped from the cabin. The two mosquitoes caught proved to be *Culex duttoni*, both females.

The third vessel on which mosquitoes were caught, namely, the s.s. "Warri," had travelled up from Sapele and Warri. In addition to those two, she had called at eleven other ports, but at all of the latter she had lain at least a mile and a half from the shore. Cargo was taken on at three ports only, besides Sapele and Warri, namely, Barracoe, Addah and Winnebah. It consisted of palm kernels in sacks and was brought out to the vessel in each case in open surf boats. It seems practically certain, therefore, that the mosquitoes found on this ship must have come all the way from the creek ports of Sapele and Warri, as it appears impossible for

them to have been brought out by the surf boats. Nor could they have come on at Freetown, since the vessel was anchored practically a mile out and I boarded her as soon as she arrived, which was in the day time. Moreover, the larval index of Freetown had just been shown by Dr. Orpen, Acting Medical Officer of Health, to be 0·4. The specimens captured were obtained from the following parts of the ship, viz., seven from the purser's cabin, three from the third mate's, one from the cabin of the second mate, and one from that of the chief engineer. Next morning a search was made in the forecastle, and after some hunting a single specimen was caught in the native quarters in the dark corner formed by the stem of the vessel.

The time occupied in the voyage from Warri to Freetown was sixteen days and about nineteen from Sapele.

Identification of the captured mosquitoes gave the following result:—*Culex duttoni*=3, *Stegomyia fasciata*=1, *Culex pipiens*=2, *Culex* (?*pipiens* type)=6, *Culex* (? sp.=1). All were females, with the exception of the *Stegomyia*, which was a male. The last named was captured in the cabin of the second officer.

Holds.—In none of the holds of any of the vessels was I able to detect the presence of mosquitoes. The only winged insects found were moths and a species of small flying beetle. These were present in all the holds with the exception of those which carried the kerosene. It seems to me unlikely that mosquitoes are carried on board these vessels in the cargo, since the latter consists, for the most part, of sacks of palm kernels, nuts, etc. A different state of affairs might of course obtain if fruit were also shipped as cargo, as one can readily imagine mosquitoes being carried out lurking in the many interstices of a large bunch of bananas, for instance. On the other hand, even if a few did find their way into a hold with the cargo they would want to get out in order to feed, when the chances were very great of their being blown overboard, since the hatches to the holds are placed on the open deck. Assuming that they did find their way into a cabin, and have gorged themselves on the unfortunate occupant, the probabilities are that they would be too sluggish to venture out on the open deck again and would simply hide themselves away in some dark corner in the cabin.

According to the officers and men of all the vessels the only places where mosquitoes give any trouble are Forcados and the various creeks thereabouts, Opobo and its creeks, and at Benin and Brass further along the coast. Okrika and Port Harcourt were

mentioned by all as the two worst. Further, I found them unanimous in stating that as soon as a vessel gets out to the open sea, any mosquitoes that have been carried out almost invariably disappear from the ship, more especially if there is a breeze blowing. They do admit, however, that, exceptionally, mosquitoes may remain on board for many days, but say that that occurs only when the weather is particularly calm and the vessel keeping more or less close to the shore and not taken long between ports. The great variation in the extent to which vessels sailing up these infected creeks are troubled by mosquitoes is interesting to note. For instance, those on board the s.s. "Warri" were greatly tormented by them, whilst the s.s. "Boma," which covered exactly the same ground about ten days later, was hardly troubled at all. Possibly the presence or absence of wind, or the direction from which it is blowing, may account for this more or less.

There were fourteen cases of illness amongst the twelve ships during the voyage. Nine of these seemed to be malarial, one intestinal, one Yellow Fever, and three with pyrexia and headache. Two died, one, according to the ship's surgeon, of malaria and hyperpyrexia, the other was the Yellow Fever case. The latter patient was taken ill and, after five and a half hours' illness died. The vessel, the "Nembe," was then at Burutu. The case was reported as Yellow Fever by the Port Authority and the ship was fumigated at Forcados. I had the opportunity of going through this vessel very thoroughly, but found no trace of mosquitoes. The whole ship still smelt very strongly of burnt sulphur.

Regarding the breeding of mosquitoes on board these ships, open receptacles containing more or less permanent collections of water were conspicuous by their fewness. The only collections of fresh water, in fact, that I was able to find, apart from that in drinking glasses in the cabins, were a couple of inches or so in three boats and a barrel about half full in another ship. A third ship had some water in three boats, which was very faintly saltish. The fresh water supply of the ship is closed in and the necessary quantities are served out from day to day.

No doubt the absence or scantiness of water in boats or other parts of the vessels can be accounted for by the fact that this investigation was carried out during a portion of the dry season. A different state of matters might, of course, obtain during the rainy season and sufficient water be left in a boat long enough to permit of mosquitoes breeding out. I am told, however, that during the

rains the plugs are left out of the boats, for fear the weight of water after a heavy shower should burst open the planking. Still, small pools might easily remain between the ribs, though continued washing with rain would tend to make them unfavourable hatching places. The above remarks would also apply in the case of salt water collections, with the exception perhaps of that in the bilges. Here there seems to be a more or less permanent supply of water, fed by drainings from the decks, from leakages between plates, and through the bearing at the stern end of the propeller shaft. The only place where the bilges are open is in the "tunnel" through which the propeller shaft runs, and I have been told by engineers that mosquitoes are sometimes found down the tunnel. Probably they get drawn down by the strong draught that comes down the tubular ventilators. As a matter of fact, *Stegomyia* has been found breeding in the bilge water. In the one bilge I examined the water was reached only after considerable difficulty, on account of various structures over the opening and the shallowness of the water in the bilge. Repeated scoopings failed to reveal any larvæ.

Nets.—Mosquito nets were seldom used on any of these vessels. As a matter of fact, I only came across one or two amongst the sailors, though all the officers possessed them. On one of the vessels, it is interesting to note, mosquito nets were supplied by the Company for all the officers and crew. This vessel was a Hamburg-Amerika trading boat which had been put on the African service. The nets were retained by the chief steward and given out when applied for. Moreover, circles of gauze wire were also on board for fitting into the port holes, and gauze frames for the doorways. None of these, however, seem to have been used on this voyage, at least by any of the crew, and on all the vessels the officers only used their nets during the few days the vessels were anchored up the various creeks and discarded them immediately they reached the open sea, preferring to be bitten by any mosquitoes remaining on board to enduring the additional stuffiness of a mosquito net in an already hot cabin.

It is doubtful indeed, if mosquito nets are of much use on board ship as, owing to the small area of the berths both in the cabins and in the crew's quarters, but particularly in the latter, divers portions of the occupant's anatomy are almost certain to be in contact with the net at some time or other during the night, and as night wear in the tropics is very often reduced to what is practically the vanishing point, the ever watchful and ready

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mosquito experiences little or no difficulty in obtaining her daily bread. In many instances also, the nets in use seemed to have been purchased without any idea of what the size of the mesh ought to be, as some that I saw were certainly capable of letting mosquitoes through, and one or two that I measured proved to have a mesh of twelve to the inch.

Identification of the mosquitoes caught was kindly carried out in the laboratory by Drs. G. G. Butler and W. B. Johnson.

In conclusion, I should like to express my appreciation of the courteous manner in which both the German and British companies and their officers on the various vessels treated me, and for the facilities they granted me for the carrying out of the investigation.

J. M. Clark.

LIST OF SHIPS EXAMINED.

Name of Ship.	Ports of Call and Time in Each.	Number of Crew.	Sickness during Voyage.	Parts of Vessel Examined.	Mosquitoes Found.	Receptacles containing Water.	Larvæ Found.	Remarks.
s.s. "Elobi"	Forcados ... 2 days Kotonon ... 4 hours Accra ... 3 hours Saltpond ... 12 hours Cape Coast Castle ... 6 hours Secondee ... 2 days Axim ... 1 day Assinie ... 1 day Grand Bassam 2 days Lahon ... 1 day Cape Palmas 12 hours Freetown ... 1 day	White ... 11 Black ... 10 Krooboys 60	None...	Cabins, saloons, etc.—A few Forecastle — Examined Holds—None	None	Boats — Several contained salt water Other vessels — Buckets in lavatory and wash-house	None	—
s.s. "Lothar-Bohlen"	Assinie ... 1 day Half Jack ... 1 day Cape Palmas 1 day Sinoe ... 1 day River Ses ... 1½ days Grand Bassam 1½ days Cape Mount 1½ days Monrovia ... 4 hours Freetown ... 5 hours	White ... 28 Krooboys 60	None...	Cabins, etc.—Several Forecastle—Yes Holds—One	None	Boats—Two with salt water; 2 in. Other vessels — None	None	—
s.s. "Bassam"	Calabar ... 5 days Lagos ... 6 days Addah ... 12 hours Accra ... 1 day Sierra Leone 4 days	White .. 23 Black ... 11 Krooboys 48	Chief Officer was ill for about a week with subtertian malaria. Recovery	Cabins, etc.—All but two Forecastle—Yes Holds—Two	None	Boats—None ... Other vessels — Barrels half full in lavatory. Some water round winches	None	A blood film showed the parasites.

LIST OF SHIPS EXAMINED—*continued.*

Name of Ship.	Ports of Call and Time in Each.	Number of Crew.	Sickness during Voyage.	Parts of Vessel Examined.	Mosquitoes Found.	Receptacles containing Water.	Larvæ Found.	Remarks.
s.s. "Patani"	Freetown ... — Sherbro ... 22 hours Freetown ... —	White ... 20 Black ... 23 Krooboys 30	None...	Cabins, etc.—All Forecastle—Yes Holds—Two	14 10 None	Boats—Two with some salt water Other vessels—A small bucket half full hanging in one of the life-boats. Water fresh	None	—
s.s. "Gando"	Opobo ... 1 week Addah ... 1 day Accra ... 1 day Winnebah ... 1 day Appam ... 1 day Secondee ... 1 day Axim ... 1 day Grand Bassam 1 day Lahon ... 1 day Cape Palmas 1 day Cess ... 2 hours Grand Bassam 1 day Monrovia ... 1 day	White ... 25 Black ... 25 Krooboys 52	Four of the white crew were ill for four or five days between Secondee and Monrovia. Diagnosed as malaria by the surgeon. Recovery in each case.	Cabins, etc.—Two Forecastle—Yes Holds—None	None	Boats—Three contained some water slightly saltish Other vessels—None	None	—
s.s. "Teneriffe"	Half Assinie $\frac{1}{2}$ day Grand Bassam 3 days Sherbro ... $1\frac{1}{2}$ days	White ... 23 Black ... 8 Krooboys 42	None...	Cabins—Six ... Forecastle—Yes Holds—One	None	Boats—One with a little slightly saltish water Other vessels—None	None	—
s.s. "Togo"	—	—	None...	Cabins—One ... Forecastle—Part Holds—None	None	Boats—None Other vessels—None	None	This vessel only came into Freetown for water and left very soon, allowing no time for examination.

s.s. "Akassa"	Akassa ... 1 day Brass ... 2 days Forcados ... 1 day Sapele ... 3 days Warri ... 4 days Benin ... 7 days Cotonou ... 1 day Accra ... 1 day Saltpond ... 12 hours Cape Coast Castle ... 12 hours Secondee ... 1 day Axim ... 1 day Assinie ... 12 hours Grand Bassam $1\frac{1}{2}$ days Cape Palmas $\frac{1}{2}$ day Grand Cess $\frac{1}{2}$ day	White ... 38 Black ... 12 Krooboys 56	The second engineer was taken ill at Saltpond, and, after four days' illness, died. The ship's surgeon diagnosed malaria with hyperpyrexia. When I left the ship three others of the crew were ill with pyrexia and headache. One of these, a boy, was able to walk about a little.	Cabins—All but two Forecastle—Yes Holds — One small one	None	Boats—One with about 2 ins. salt water Other vessels—None	None	—
s.s. "Nembe"	Forcados ... 2 days Burutu ... 5 days Lagos ... 21 days	White ... 22 Black ... 10 Krooboys 38	The assistant cook, a white boy, was taken ill at Burutu, and died in $5\frac{1}{2}$ hours. Reported as Yellow Fever by the Port Authority, and the ship was quarantined and fumigated.	Cabins—All ... Forecastle—Yes Holds—Three	None	Boats—None ... Other vessels—None	None	—
s.s. "Henrietta Woermann"	Assinie ... 2 days Cape Palmas 1 day Sasstown ... 1 day Sinoe ... 1 day Grand Bassam 1 day Cape Mount 1 day Manoh ... 1 day Sulimah ... 1 day Monrovia ... 2 days Freetown ... 6 hours Sherbro ... $1\frac{1}{2}$ days	—	None...	Cabins—One ... Forecastle—Yes Holds—None	1 1 None	Boats—none examined Other vessels—None looked for	None	Only came into port to drop the pilot, so gave no time for a longer examination

List of Ships Examined—*continued.*

Name of Ship.	Ports of Call and Time in Each.	Number of Crew.	Sickness during Voyage.	Parts of Vessels Examined.	Mosquitoes Found.	Receptacles containing Water.	Larvæ Found.	Remarks.
s.s. "Warri"	Sapele ... 4 days Koko ... 2 days Warri ... $2\frac{1}{2}$ days Forcados ... 19 hours Addah ... $1\frac{1}{2}$ days Accra ... 6 hours Winnebah ... 1 day Barracol ... 16 hours Appam ... 2 hours Saltpond ... 2 hours Cape Coast Castle ... 11 hours Secondi ... $6\frac{1}{2}$ hours Axim ... $1\frac{1}{2}$ days	White ... 23 Black ... 10 Krooboys 39	Two of the white crew were taken ill about Axim, one apparently malaria, the other due to heat. Both were getting well when I saw them.	Cabins—Six ... Forecastle—Partly Holds—One and part of another	12 1 None	Boats—Three contained a moderate amount of fresh water Other vessels—None	None	—
s.s "Boma"	Sapele ... 3 days Koko ... 2 days Warri ... 2 days Forcados ... 1 day Addah ... 1 day Accra ... 1 day Appam ... 1 day Winnebah ... 1 day Saltpond ... Few hours Cape Coast Castle ... 1 day Secondi ... 2 hours Axim ... 1 day	White ... 22 Black ... 10 Krooboys 42	Captain was ill at Axim with malaria, and a quarter-master at Freetown. The former was nearly well when I was on board. The latter had only just been taken ill.	Cabins—All but two Forecastle—Yes Holds—One	None	Boats—None ... Other vessels—None	None	—

[*Enclosure* 2.]

THE MEDICAL OFFICER OF HEALTH TO THE SENIOR SANITARY OFFICER.

SIR,

In answer to your memorandum of 13th June, 1914, asking for a report on the presence, and when present, the degree of prevalence, of the *Stegomyia* mosquito in vessels other than steamers, I have the honour to report as follows the result of my investigations.

In this connexion vessels of every class which were lying in this port, other than ocean-going steamers, have been examined.

2. (*a*) Two steam launches which sail between Port Lokkoh and Freetown were each examined on two occasions but nothing was discovered.

(*b*) Two steam tugs which are used in the harbour for towing lighters, etc., were examined but nothing discovered.

(*c*) Three small schooners which sail from Freetown and Gambia, Great Scarcies, Kambia River, etc., were examined. In one, which had just come from Gambia, a specimen adult of *Pyretophorus costalis* was found in the cabin. In the other nothing was discovered.

(*d*) Boats which ply between the harbour and the shore.

(1) Those plying the Bay and in use. Twelve were examined. All contained salt water and nothing discovered.

(2) Those lying on the shore, not in actual use. Fifty were examined. Thirteen contained fresh water with mosquito larvæ. The larvæ were bred out and found as follows :—

Stegomyia fasciata, one ; *Stegomyia sugens*, five ; *Culex duttoni*, four ; *Culex pipiens*, three.

(*e*) Lighters lying in the harbour and used for carrying cargo from ship to shore. Fourteen were examined. All were made of wood, contained salt water, with the exception of two, which were made of iron and contained fresh water with mosquito larvæ. These bred as follows :—

Culex pipiens, one ; *Stegomyia sugens*, one. In none of these cases were larvæ numerous.

(*f*) Native boats sailing from Freetown and Bullom for market purposes, a distance of about twelve miles. Twenty of these were examined. All were found to contain salt water and nothing was discovered.

(*g*) Native canoes. (1) Those actually in use. Seven were examined and found to contain salt water. Nothing discovered. (2) Those not in use. Two lying on the beach were examined and found to contain fresh water with mosquito larvæ. *Stegomyia sugens* bred out in both cases.

(*h*) I also examined the s.s. "Fulani," which was ashore on "Carpenter Rock." Six specimens of *Pyretophorus costalis* were discovered. The vessel was lying about one mile from shore and in the direction of the prevailing wind. The probability is that the mosquitoes had been brought from ports lower down the coast.

I have, &c.,

WILLIAM ALLAN,
Medical Officer of Health.

GOLD COAST.

THE ACTING GOVERNOR TO THE SECRETARY OF STATE.

(Received 3rd July, 1914.)

Government House, Accra,
13*th June*, 1914.

SIR,

With reference to your despatch of the 16th of December last, regarding the conditions of the sea-borne traffic of the West African ports, with special reference to the circumstances favouring the introduction of Yellow Fever by this means, I have the honour to transmit to you, herewith, a copy of a letter from the Principal Medical Officer summarizing the reports received by him from the Medical Officers at the various ports on the Gold Coast.

I have, &c.,

W. C. F. ROBERTSON,
Acting Governor.

[*Enclosure.*]

Medical Department, Victoriaborg, Accra,
5*th June*, 1914.

SIR,

I have the honour to submit a report in accordance with the terms of the Secretary of State's despatch of 16th December, 1913.

The following ports in this Colony supplied the information which may be summarized as follows :—

Port.	Number of Steamers Inspected.	Result.	
Axim ...	15	Negative.	
Seccondee	Numerous	,,	
Elmina ...	6	,,	
Cape Coast	Numerous	,,	
Saltpond ...	,, ...	,,	
Winnebah	Nil return owing to pressure of work	—	
Accra ...	7	Negative.	
Addah ...	1 coasting steames (Lagos)	,,	
,, ...	1 ocean going cargo steamer (Lagos).	Positive.	*Stegomyia calopus*, no larvæ.
,, ...	2 bar steamers	,,	*Stegomyia calopus*, no larvæ.
,, ...	6 river launches	,,	*Stegomyia calopus*, no larvæ.
Quittah ...	Nil return owing to pressure of work	—	

Note.—No report from Half Assinie as there was no Medical Officer there owing to shortage of staff.

The ports are given in order from windward to leeward, *i.e.*, west to east.

The reports indicate that unused boats, canoes, and other craft breed *Stegomyia calopus* should they have collections of rain water in them.

Only one ocean-going cargo steamer, s.s. "Muraji" (Addah) had *Stegomyia calopus* on board, although no likely breeding places were discovered, so it must be presumed they were carried from some leeward port but not a Gold Coast one. It might be argued that she obtained them from the bar steamers at Addah where she was lying, but that idea may be dismissed, as these steamers

lie too far away from the ocean-going ones in Addah roads and to leeward.

It is admitted that in this Colony it is unlikely, and I go so far as to say impossible, for mosquitoes to get from shore to ship.

That mosquitoes are found on occasions on the homeward-bound mail and cargo steamers is pretty well known, and I can personally vouch for the fact, but it is not to be wondered at when it is taken into account when they lie in the Nigeria ports and often with branch steamers tied up alongside. The latter, in my long experience of Nigeria, almost invariably harbour mosquitoes, and not alone that, but I have actually found them breeding in large numbers on board.

I have, &c.,

F. G. HOPKINS,

Principal Medical Officer.

The Honourable
The Colonial Secretary,
Victoriaborg, Accra.

NIGERIA.

THE GOVERNOR-GENERAL TO THE SECRETARY OF STATE.

(Received 28th November, 1914.)

Government House, Nigeria,
7th November, 1914.

SIR,

With reference to your despatch of the 16th December, 1913, on the subject of information required by the Yellow Fever (West Africa) Commission in regard to the conditions of the sea-borne traffic of the West African ports, I have the honour to transmit herewith a copy of a report from the Director of the Medical and Sanitary Service, covering a letter from the Principal Medical Officer, Southern Provinces, containing extracts from reports by Medical Officers who have been stationed during the current year in the various ocean and river ports of the Southern Provinces.

I have, &c.,

F. D. LUGARD,

Governor-General.

[*Enclosure.*]

COLONIAL SECRETARY,

The number of river craft and canoes containing larvæ is much smaller than I anticipated; this is probably due to the recent examinations that have taken place on them. The Medical Officer, Bonny (Dr. Bailey), has had considerable experience of stern-wheelers when he was stationed at Forcados-Burutu, and I rather think his remarks apply to that period of his career. In any case, the present Medical Officer at Forcados-Burutu (Dr. Booth), finds a large percentage of river craft, presumably launches and stern-wheelers, with mosquitoes on board, but only two with larvæ.

The report omits one important particular throughout, and this is the length of time that elapsed between the arrival of an ocean ship and the examination. This omission nullifies to a great extent the value of the report in regard to sea-borne traffic. This investigation, however, reveals the important fact that mosquitoes are conveyed from one port to another, both by ocean steamships and river craft.

T. HOOD, D.M.S.S.

30*th October*, 1914.

Lagos, 15*th October*, 1914.

SIR,

I have the honour to forward you the following information extracted from the various reports received from Medical Officers, in reference to the introduction of Yellow Fever by sea-borne traffic.

Epe.—The Medical Officer reports that the shipping of the port consists of canoes, which invariably contain some water on the bottom of the canoe under a grating of sticks. He states he has frequently examined this water, but has never found any larvæ therein.

Badagry.—The Medical Officer reports that Badagry is the principal trading centre on the lagoon between Lagos and Porto-Novo. He states the facilities for the introduction of Yellow Fever are numerous:—(1) Large trading canoes from Lagos, about twenty weekly; (2) the French mail launches, which run twice weekly between Lagos and Porto Novo, call at Badagry; (3) German branch steamers. The Medical Officer reports these branch boats and lighters are favourite haunts of *Stegomyiæ*.

Lagos.— The following are the figures supplied by Dr. Laurie for this port :—

	Inspected.	Larvæ.	Larvæ. Percentage.	Adults.
Steamships ...	436	—	—	18
Boats, barges ...	549	23	4·1	—
Canoes	14,751	54	·36	—
		Stegomyia fasciata ...		15
		Culex decens ...		3

Aboh.— The Medical Officer reports that since the beginning of the year no vessels calling at Aboh have been at sea.

Forcados.—The Medical Officer reports that he examined thirty-seven ships ; seven of these ships had *Anopheles* and eight ships *Culicines*—no larvæ were found. These were all ocean-going steamers.

Burutu.—The Medical Officer at Burutu reports that out of eighty-six ships examined five contained *Anopheline*, nine *Stegomyia*, and fourteen *Culicine* mosquitoes ; on two ships only were larvæ found.

The above were all river craft.

Onitsha.—No larvæ have been found in any vessel in this station. The steamers are river boats. No ocean boats are plying, canoes are local, and no cases of Yellow Fever have been observed.

Sapele.—The Medical Officer has examined 391 of all craft ; on steamers neither mosquitoes nor larvæ were found ; *Stegomyia* mosquitoes were found on one steam launch and one lighter, and 82 canoes contained water with larvæ, 22 of which on breeding out proved to be *Stegomyia*. *Stegomyia* mosquitoes were caught on five other canoes.

Warri.—The Medical Officer reports that from 75 per cent. to 90 per cent. launches and steamers have mosquitoes, the degree of prevalence of *Stegomyia* being small, the larval stage being only found on river-going steamers and canoes. Warri being an inland port all the steamers and launches have been tied up at the various wharves getting there ; this probably accounts for the high percentage of mosquitoes found on board.

Degema.—Thirteen ocean-going steamships examined, no larvæ found, but three contained mosquitoes, two of these vessels having *Stegomyia*. Of 57 steam launches and river steamers larvæ were found on three, which, on hatching out, proved to be *Stegomyia* ;

on 27 of these vessels mosquitoes were observed, mostly *Stegomyia* Of 1,450 trading and carrying canoes very few contained larvæ, and in all cases these were found in pots used for storing water; on hatching they were *Stegomyia*.

Bonny.—The Medical Officer reports main line steamers free. Branch boats have a few mosquitoes, larvæ found once in twenty examinations. Stern-wheelers without exception harbour *Stegomyia* mosquitoes in large numbers. He is of opinion that from a breeding and distributing point of view stern-wheelers are probably the most important vessels in the country.

Brass-Akassa.—The Medical Officer has furnished a nil report.

Calabar.—No larvæ on steamers, some adult mosquitoes, no *Stegomyia*. In launches no larvæ, but a few adult *Stegomyia*. Of 73 lighters inspected four had larvæ, mostly *Culex*, with a few *Stegomyia*. 1,113 canoes were inspected, ten had larvæ, chiefly *Culex*.

I have, &c.,

H. B. S. MONTGOMERY,

for Principal Medical Officer.

REPORT ON THE EXAMINATION OF HUMAN BLOOD IN ENGLAND FOR THE PRESENCE OR ABSENCE OF "SEIDELIN BODIES"

(*Paraplasma flavigenum*, the so-called Parasite of Yellow Fever).

BY

JOHN WESTRAY CROPPER, M.B., CH.B., M.SC. (L'POOL).

(*The John Howard McFadden Researches, The Lister Institute of Preventive Medicine.*)

At the request of the Yellow Fever (West Africa) Commission I have examined the blood of a number of persons resident in England for the presence or absence of "Seidelin bodies." None of these persons had been exposed to yellow fever, and with a few exceptions they had not been out of England. The persons examined included a large proportion of children, and the majority of them, both adults and children, suffered from anæmia. The examination was made owing to some doubt having been thrown on the nature of the bodies described by Seidelin, from the fact that they had been found in the blood of persons who were not supposed to be suffering from yellow fever, and also from their discovery in the blood of various animals, particularly young ones.

The bodies discovered by Seidelin in the red blood corpuscles of yellow fever patients exhibit a variety of appearances, which depend to some extent on the stage of the life-cycle which the "parasite" has reached. The characteristic appearance which has guided me in the search for these bodies was the association together, in the corpuscle, of a scarlet staining dot and a bluish-grey area which may assume many different shapes. It was considered advisable to find bodies which leave no room for doubt as to their identity with the "Seidelin bodies."

Technique.—The blood was in all cases taken from the finger with a sterile needle and was transferred to a clean slide by means of a cigarette paper. The film thus obtained was dried by waving in the air, and was fixed in pure methyl alcohol for about an hour. It was then stained in eosin-azur solution for 24 hours, washed in tap water, blotted dry, and mounted in canada balsam, cedar oil or parolein. The solution of stain was made by dissolving one eosin-azur soloid (Burroughs, Wellcome & Co.) in 10 cc. pure methyl alcohol and diluting this to the proportion of 1–20 with faintly alkaline distilled

water. When properly stained to demonstrate "Seidelin bodies" the red corpuscles appear a homogenous dark pink colour, the nuclei of the leucocytes being deep purple and their granules scarlet. It is important to attend to these details when searching for the bodies in such scanty numbers as I have found, otherwise they may be missed altogether. Each film requires from one to two hours' examination to observe every red corpuscle.

Results of Examination.—In 284 blood films from 102 persons, 68 of whom suffered from anæmia, I have been able to find five bodies (Plate 1) similar in appearance to those described by Seidelin in the blood of yellow fever patients. Two of the bodies occurred in a child of three years of age, and the remaining three in children aged two, three, and ten respectively. None of these cases had been exposed to yellow fever, but all of them suffered from anæmia. In addition to these about a dozen bodies were seen which, owing to their minute size and difficulty of distinction from artefacts, have been discarded as doubtful. In three other cases the scarlet dot was found in the corpuscle without the blue area, and in one case the blue staining portion was alone (Plate I., No. 7). None of the bodies have been seen free in the blood. Several films of fœtal blood were taken from the umbilical cord immediately after birth but were unfortunately spoiled.

The cases examined are given in detail in the Tables I. to III., and the most typical bodies found are shown in the accompanying coloured plate.

I have been unable to distinguish the bodies which I have found in human blood in England from those in the original preparations of Seidelin (some of which I have seen), and from the coloured drawings of *Paraplasma*-like bodies in papers by Macfie & Johnston and Wenyon & Low.

I have no opinion to offer as to the nature of the bodies. Various writers have already suggested their connection either with the development of, or with degenerative changes in, the red corpuscles. I do not feel justified, from the small number of positive cases, in stating that the bodies are due to anæmia, as several very anæmic patients gave negative results. The finding of the bodies in such small numbers is so difficult that they may have been missed in these cases. The bodies were also apparently absent in three cases with nucleated red corpuscles, and in three cases with a leucocytosis.

TABLE I.

PERSONS SUFFERING FROM ANÆMIA: ADULTS, AND CHILDREN ABOVE FIVE YEARS.

No.	Sex.	Age.	Remarks.	Number of films examined.	"Seidelin bodies."
1	M	19	—	2	Nil.
2	M	15	After diphtheria	4	Nil.
3	M	18	After scarlatina	3	Nil.
4	M	21	After pneumonia	2	Three doubtful bodies.
5	M	15	—	2	Nil.
6	M	30	Leucocytosis	2	Nil.
7	M	34	—	2	Nil.
8	M	18	After scarlatina	2	Nil.
9	F	13	After diphtheria	2	Nil.
10	M	27	—	2	Nil.
11	M	20	After influenza	4	Two doubtful bodies.
12	F	18	Chlorosis	4	Nil.
13	F	15	Chlorosis	2	Nil.
14	F	13	Chlorosis	2	Nil.
15	F	12	After diphtheria	2	Nil.
16	F	10	Severe anæmia	4	Nil.
17	F	16	Severe anæmia	4	Nil.
18	M	13	—	2	Nil.
19	F	6	—	2	Nil.
20	M	40	Malaria 10 years ago	4	Several doubtful bodies.
21	F	8	Slight anæmia	2	Nil.
22	F	10	Lymphocytosis	2	Nil.
23	F	20	Cystitis	2	Nil.
24	M	23	—	2	Several doubtful bodies.
25	M	5	—	2	Nil.
26	M	8	—	4	Nil.
27	M	10	—	4	Nil.
28	F	12	A few nucleated erythrocytes	3	Nil.
29	F	10	—	2	Nil.
30	F	14	—	2	Nil.
31	F	10	After appendicitis	3	One ring-shaped body.

TABLE I.—continued.

No.	Sex.	Age.	Remarks.	Number of films examined.	"Seidelin bodies."
32	F	12	—	2	Nil.
33	F	6	—	3	Nil.
34	M	5	—	2	One doubtful body.
35	M	6	Severe anæmia	4	Nil.
36	F	5	—	2	Nil.
37	F	8	Slight anæmia	2	Nil.
38	M	6	—	1	Nil.
39	M	10	After diphtheria	2	Nil.
40	M	12	Slight anæmia	1	Nil.
41	F	6	—	2	Nil.
42	M	10	—	2	Nil.
43	F	14	Slight anæmia	2	Nil.
44	M	12	—	2	Nil.
45	M	10	—	2	Nil.
46	M	7	After scarlatina	4	Nil.
47	M	6	—	4	Nil.

TABLE II.

PERSONS SUFFERING FROM ANÆMIA: CHILDREN UNDER FIVE YEARS.

No.	Sex.	Age.	Remarks.	Number of films examined.	"Seidelin bodies."
1	M	4	Marked anæmia	4	Nil.
2	F	4	Slight anæmia	4	Nil.
3	M	4	Tabes, marked anæmia	4	Nil.
4	M	2	Several nucleated erythrocytes	4	Nil.
5	F	2	—	4	One linear-shaped body.
6	F	5	—	4	Nil.
7	M	4	—	4	Nil.
8	F	3	Slight anæmia	2	Nil.
9	M	2	—	4	Nil.
10	M	3	Slight anæmia	2	Nil.
11	M	3	A few nucleated erythrocytes	3	Nil.
12	F	3	—	3	Two bodies found.
13	M	2	—	3	Nil.
14	F	3	After diphtheria	3	Nil.
15	M	3	Slight anæmia	4	One irregular-shaped body.
16	M	4	—	3	Nil.
17	F	3	Severe anæmia	4	Nil.
18	F	3	—	4	Nil.
19	M	4	After influenza	4	Nil.
20	M	3	—	4	Nil.
21	M	4	After diphtheria	4	Nil.

TABLE III.

PERSONS WHO WERE NOT ANÆMIC: ADULTS AND CHILDREN.

No.	Sex.	Age.	Remarks.	Number of films examined.	"Seidelin bodies."
1	M	38	Enteritis, lymphocytosis	2	Nil. Nil.
2	F	16	Healthy	2	Nil.
3	F	36	Healthy	2	Nil.
4	M	10	Hæmophilia	2	Nil.
5	M	7	Bronchitis	2	Nil.
6	M	12	Measles	2	Nil.
7	F	14	Nephritis	2	Nil.
8	M	18	Rheumatic fever	2	Nil.
9	M	6	Healthy	2	Nil.
10	F	8	Measles	2	Nil.
11	M	12	Influenza	3	Nil.
12	M	16	Phthisis	4	Nil.
13	F	12	Healthy	4	Nil.
14	M	11	Healthy	4	Nil.
15	M	6	Healthy	3	Nil.
16	M	8	Measles	2	Nil.
17	F	5	Healthy	4	Nil.
18	F	5	Healthy	4	Nil.
19	F	22	Plumbism	2	Nil.
20	M	28	Tonsillitis	2	Nil.
21	M	30	Epilepsy	1	Nil.
22	M	28	Diabetes	2	Nil.
23	M	18	Jaundice	3	Nil.
24	F	14	Tonsillitis	2	Nil.
25	F	3	Healthy	2	Nil.
26	F	4	Healthy	4	Nil.
27	M	5	Healthy	4	Nil.
28	F	42	Diabetes	4	Nil.
29	M	14	Pneumonia	4	Nil.
30	F	3	Healthy	2	Nil.
31	F	5	Healthy	2	Nil.
32	F	2	Rickets	3	Nil.
33	F	5	Healthy	2	Nil.
34	M	10	Diphtheria	4	Nil.

PLATE I.

Bodies resembling "Seidelin bodies" found in the blood of persons in England who had not been exposed to Yellow Fever.

Nos. 1–5. Typical bodies.
No. 1. Scarlet dot and irregular-shaped body.
,, 2. Scarlet dot and semi-circular blue body.
,, 3. Scarlet dot and Y-shaped blue body.
,, 4. Scarlet dot and linear blue body.
,, 5. Scarlet dot and ring-shaped blue body.
,, 6. Scarlet dot only.
,, 7. Two linear blue bodies only.

All figures drawn direct from the microscope with the camera lucida.

NOTES ON THE REARING OF *STEGOMYIA FASCIATA* IN LONDON.

By Malcolm Evan MacGregor.

(*Wellcome Bureau of Scientific Research.*)

(*Reprinted from "Journal of Tropical Medicine and Hygiene," Sept. 1st, 1915.*)

In May of this year the Bureau was presented by Sir James Kingston Fowler, Chairman of the Yellow Fever Commission, with a few dried leaves of the West African cottonwood tree, on which were eggs of *Stegomyia fasciata*, these having been sent to the Colonial Office by Mr. A. W. Bacot from West Africa (Sierra Leone).

The leaves had been a fortnight in transit and had remained at the Colonial Office for three months, being thus, at the very least, three-and-a-half months in a dried condition ere they reached my hands, while from what I hear they may very probably have been dried for a considerably longer period. These leaves were packed between grease-proof paper in a small cardboard box, and were in a thoroughly desiccated state.

On examination under the binocular microscope I found a fairly large number of eggs adhering to the leaves, for the most part secured by a fine deposit of dried mud.

About 75 per cent. of the eggs were apparently dried up, with their shells crinkled and shrivelled, while the rest looked normal. I therefore examined specimens of both by breaking them open with needles, and found them to contain moisture and partly formed larvæ.

The leaves were then cut up into pieces about 1 in. square and placed on tap water in glass containers and kept at the temperature of the Laboratory (18° C.). This was done at 11.30 a.m. on April 29, and by 9.30 a.m. the next day the water was crowded with larvæ that had hatched out in such numbers as to leave me in no doubt that the shrivelled eggs, as well as the normal, had been viable.

Larval Food Supply.

This first generation of larvæ was divided into approximately equal numbers and placed in separate containers: No. 1 containing tap water contaminated with straws from horse manure and the organic matter and bacteria thereon; No. 2 containing fresh water from the Serpentine Lake in Hyde Park. Both containers were then placed under equal conditions of light and temperature. Four days later the larvæ in container No. 1 had grown and greatly increased in size, while those in container No. 2 appeared to have hardly grown at all, and were moreover sluggish in their movements compared with the former. The waters of both containers, together with the respective larvæ, were therefore then mixed and more straws from the horse manure added.

Optimum Temperature with given Food Supply.

To determine the optimum temperature with the above food supply for rearing the larvæ in the Laboratory, eight lots of twenty larvæ, of as nearly as possible one size, were placed in eight small beakers, together with equal supplies of water from the main container.

These beakers were arranged along a copper sheet, heated by a small Bunsen flame at one end, at varying distances from the heated end, and when the temperature of the water in each beaker had become constant, it stood as follows:—

No. 1.	16° C.	No. 4.	25·9° C.	No. 7.	37° C.
No. 2.	19·5° C.	No. 5.	30·8° C.	No. 8.	41·4° C.
No. 3.	23·8° C.	No. 6.	35·2° C.		

From the beakers at the higher temperature evaporation was somewhat rapid, but was compensated for by the addition of tap water in order to keep the concentration of the food supply also constant. This, obviously, would not have been the case if water from the main container had been used.

In order to avoid a somewhat unwieldly table, giving dates of pupation and emergence of first imagos, &c., the results may be briefly stated as follows.

In beaker No. 4 (temperature 25·9° C.) the larvæ seemed to do best, and the mosquitoes which bred out from this beaker were certainly the largest and strongest specimens. In No. 3 (temperature 23·8° C.) the imagos, when they emerged, were perhaps equally

fine specimens, but they were, as an average, three days longer in the complete metamorphosis. At temperatures below this the number of days for the metamorphosis was considerably prolonged. In beaker No. 1 one or two of the larvæ died, and the imagos on emergence were undersized and somewhat feeble. At the higher temperatures, that is, in beakers Nos. 5, 6, and 7, the average date of emergence of the imagos was several days in advance of those in beaker No. 4, and the specimens were very much undersized, though all were active and apparently healthy. The larvæ in beaker No. 8 (temperature 41·4° C.) all died within a day.

Thus it will be seen that with the food supply and the light conditions used the optimum temperature was from 23° to 26° C., and this has been the temperature adopted for the subsequent generations. At this temperature, and with this food supply, the average larval period was ten days, and the average pupal period six.

Males and Females.

On emergence the male and female mosquitoes were transferred to a small cage consisting of a wooden box that had had top and bottom removed and screened with butter muslin. It was observed that copulation took place almost as soon as the mosquitoes were able to fly, and before any food had been given to them. The mating took place usually in mid-air, and the female was fertilized as the pair flew slowly about, or, as more often happened, the female immediately settled on the muslin or sides of the cage, and copulation took place there, the male being in a peculiar position with his back and wings pressed against the support on which the female rested, with the abdomen arched upwards.

It was found that the mosquitoes would readily feed on a black guinea-pig, and this has furnished the food supply for the adult females. A black guinea-pig was used becaused a marked preference was noticed in the mosquitoes for this colour. At one time a white animal was substituted, and the mosquitoes could not be induced to attack it at all readily, even when the hair on the back was shaved ; while the one or two that settled and commenced to feed were instantly disturbed by the slightest movement on the guinea-pig's part, and would fly off to the far ends of the cage and remain there.

When the white guinea-pig was removed and a black one put in, the mosquitoes attacked it vigorously, and no amount of persistent endeavour to drive them off that the guinea-pig indulged in was successful. I have noticed partially gorged mosquitoes sitting on the black animal's head, apparently quite oblivious of the most violent head-shaking.

It was also noticed that the mosquitoes, before they had partaken of their first meal of blood, did not attack the guinea-pig in the voracious manner they adopted at subsequent meals, when, as it were, they had "tasted blood."

Length of Life in Males and Females.

Under the conditions that the mosquitoes live at the laboratories it has been found that as an average the males live from ten days to three weeks, while the females live from a month to six weeks, while some are alive still after two-and-a-half months.

Feeding Habits of Female and Oviposition.

An average specimen female will become completely engorged with blood in from three to five minutes, and when replete is so heavy that she can barely fly, and usually prefers to hop off the guinea-pig on to the floor of the cage, and crawl up the sides, taking refuge in the darkest place she can find.

The eggs in the ovaries would seem to require from three to five days in which to become mature after the blood meal, and oviposition was found to have taken place in all cases within this period.

When all the mosquitoes have fed that are inclined to do so, it has been the custom to remove the guinea-pig from the cage and place therein a small Petri dish partially filled with tap water, or the water used in rearing the larvæ, with a few small leaves floating on the surface.

The eggs are deposited for the most part directly on the surface of the water, but many are also attached to the leaves it is found. In neither case, however, are they laid with much attempt at system, and the best that can be said is that they tend to be deposited in irregular clusters. Apparently the eggs must not be submerged for any length of time before they hatch, and it has been found

that water with eggs floating on the surface, when poured from one vessel to another (and the eggs therefore thoroughly wetted), causes the eggs to sink to the bottom and very few larvæ then hatch out.

Individual females have made as many as eight separate ovi-positions, and will feed again readily within a day after laying each batch of eggs.

Males.

Careful study of the habits of the male over the period of its life within the cages convinces me that while it does not suck blood as the female does, yet it is very fond of occasionally working its proboscis over the guinea-pig's skin and appears to draw up minute quantities of sweat and saliva from a "licked" part. Males are often also seen resting on the water in the Petri dishes, with the tip of the proboscis submerged, and apparently drinking.

The males are most active in the afternoons, and seem ever ready to mate with females on the wing, but in no instance has it been observed that a male will approach a *resting* female. If the sides of the cage are knocked and the resting mosquitoes made to take to the air, the males immediately unite with the female mosquitoes and copulation may take place while they are both on the wing, or the female will alight and the male be driven against the cage in the peculiar attitude that I have described elsewhere in this paper.

When the guinea-pig is in the cage the males show a marked preference to sitting on it rather than on the sides of the cage, and seem to choose the tips of the ears as a favourite resting place. They will sit there if not disturbed for an hour or more, with the plumes and antennæ at times in rapid vibration.

The Pupæ.

The pupal condition is usually attained during the night, but if the larvæ are kept in a fairly dark place this change can be observed. The fully grown larva, which is about to pupate, can be distinguished by its becoming almost opaque, and of a yellowish white colour except for the head ; the usual dark line in the larvæ that marks the alimentary tract having disappeared. On pupation the larval skin splits open on the dorsal side of the thorax, and

with much wriggling the pupa struggles out. This manœuvre is often accomplished at the bottom of the tank, and the withdrawing of the "tail" end seems to occasion the most difficulty, but the change is completed very rapidly indeed—often within 30 secs. When the pupa first emerges it is of the same yellowish-white colour, but in the course of a few hours becomes darker, and the colour of the pupa is a fair indication of the stage it has reached before the emergence of the adult.

The Larvæ.

When first hatched they are about 1 mm. long and 0·3 mm. at greatest breadth, quite white, and rather difficult to see if the container is not placed on a black background. The larvæ grow very rapidly, and in a few hours at a temperature of 25° C. are much larger and more conspicuous by the head having enlarged, and become dark in colour.

For some time it was customary to give the larvæ the food furnished by simply adding a few straws from horse manure to the water; but, as one would naturally expect, the quantity of food furnished by this means was uncertain, and while it amply sufficed for their needs in some instances, it was insufficient in others. By accident a pellet of the guinea-pig's fæces was added one day, and the larvæ were seen to feed greedily upon it, even in the presence of an abundant supply of other food, and since then guinea-pig's fæces have been regularly added to the water, the larvæ thriving splendidly in consequence.

With the water from the Serpentine Lake that was used in the first experiment, one or two cyclops were introduced, and in the subsequent mixing of the waters descendants have been introduced into all the containers. They do not, however, seem to interfere with the larvæ, nor do the latter appear to attack the cyclops. Nevertheless, that the larvæ like animal food can be demonstrated by adding newly hatched larvæ to the same container that holds well-grown individuals, the young larvæ, even if added in large numbers, being speedily consumed by the others.

It is common knowledge that the larvæ of mosquitoes very readily react to light, and that the larvæ of *Stegomyia* avoid it and seek the darker places in which to live, except if forced into light

when they come to surface to breathe. Mitchell* has recorded the fact that some mosquito larvæ also react to what appears to be a sense of smell, and though I have not seen it recorded elsewhere, I find that *Stegomyia* larvæ apparently react to sound as well. It was noticed that whenever a mercury break, that is attached to an X-ray apparatus in my laboratory, was switched on, the larvæ immediately dived to the botton of their containers when the high-pitched note that the mercury break emits commenced. The X-ray apparatus and the containers are separated by the length of the laboratory, and are some considerable distance apart, so that it is not due to simple vibration. Thinking that the container might resonate with the note of the break, the larvæ and water were transferred to another vessel possessing a totally different vibration period to the first. However, as before, the larvæ would immediately dive when the note of the break sounded. It was also found that a sharp whistle would make them react in the same way.

Until fully grown the larvæ of *Stegomyia* are semi-transparent in parts of their bodies, but when about to pupate they cease to feed, and most of the food in the alimentary tract is either digested and absorbed, or excreted, and the larvæ become more opaque and of a yellowish colour, so that individuals about to pupate can be readily distinguished.

The Eggs.

These have been laid in very large numbers about three to five days after the females have fed, and kept at a temperature of 30° C. (which has been found to be the optimum for the development of the eggs under the existing conditions) they have hatched in an average from three to five days. The variation in individual eggs from the same batch in the incubation period is remarkable, however, some being several days longer in hatching than the rest, and in many cases eggs laid at one time by the same female and kept under precisely uniform conditions will hatch out irregularly over a period as long as ten days or a fortnight, for some reason I have not yet been able to determine. It may possibly be a protective provision in Nature to guard against the chance of all the larvæ hatching before a rain or other pool has become established.

* "Mosquito Life." By E. G. Mitchell (1907).

Remarks.

Although the rearing of *Stegomyia*, after the eggs have been desiccated and sent through the post, has been accomplished before by several observers, notably by Theobald, Newstead, Francis, Peryassu, and others,* yet, as far as I can determine, the present investigations at the Bureau have succeeded in producing the greatest number of subsequent generations from such eggs, the sixth generation now having been established among my mosquitoes. There has been no loss in the size or vitality of the insects, and it is now hoped that with the apparatus that has been constructed and fitted up in the Museum of the Bureau that a permanent exhibit of the life-history of *Stegomyia fasciata* has been set up for observation by any-one interested in the subject.† Similar apparatus is also to be used in an attempt to rear *Anophelines* and *Culex pipiens* in the same way for comparative purposes.

It had been hoped that experiments might have been undertaken in comparative temperature, experiments, &c., between *Stegomyia fasciata* larvæ and those of *Culex pipiens*, since in the course of my work I was called upon to determine the species of a mosquito that was found breeding in a "sump" pit at the Highgate Station of the Underground Railway, and which turned out to be the latter insect.

These insects were breeding in enormous numbers and situated in the "sump" pit were at a distance of 120 ft. below the ground. The conditions were so extraordinary that I hope to write a brief note on the subject for separate publication. I was thus enabled, however, to obtain large numbers of larvæ with which I intended to conduct the above-mentioned comparative studies, but they unfortunately speedily died in my laboratory, due, I think, to the fact that they had lived in complete darkness beforehand and could not tolerate the conditions I transferred them to.

Recently, nevertheless, I have obtained large numbers of larvæ of the same mosquito from a different source, and these are living well, so that I hope to be able to conduct the experiments in mind shortly.

It is particularly interesting to record the fact that Dr. A. C. Stevenson, of this Bureau, while engaged in searching for endo-

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* See "A Text-book of Medical Entomology," by Patton and Cragg.

† Since these Notes were first published in the "Journal of Tropical Medicine and Hygiene" other four months have elapsed, with several successive generations, and the mosquitoes are still (January, 1916) as vigorous as ever.

parasites in the *Stegomyia* larvæ, discovered a very large percentage to be infected with *Lankesteria culicis*. This parasite was first described by Ross in 1898, when he found it in *Anophelines* in India, and was subsequently found by others, and by Wenyon in *Stegomyia fasciata* larvæ in Bagdad. The parasite has been particularly carefully studied and described by the latter investigator,* and a record of the discovery of the parasite in the larvæ I have been working with from West Africa is to be published by him elsewhere. ("Journal of Tropical Medicine and Hygiene," September 1st, 1915.)

By the demonstration once more of the remarkable resistance of the eggs of *S. fasciata* to desiccation, attention is called again to the fact of what this may very easily mean in the distribution of this mosquito, and hence its bearing in the spread of yellow fever.

It is clearly conceivable that dried leaves with eggs attached might, by wind alone, be spread over immense distances, while by export of raw materials in bales of all sorts, dried leaves with the eggs adhering could be very well distributed to the ends of the earth. Moreover, the hardiness of *S. fasciata* would permit of its establishing itself in many places where it is not found to-day, and with the vector of yellow fever present, the living virus—if such it prove to be—need only be introduced into the infested area for the danger of an epidemic to be made manifest.

Short List of Literature which deals with Mosquito Life-histories.

Berkeley, W. N. (1902). "Laboratory work with Mosquitoes."

Giles, G. M. (1902). "Gnats or Mosquitoes, including a Revision of the *Anophelines*."

Goeldi, E. A. (1905). "Os Mosquitoes no Para."

Howard, L. O. (1901). "Mosquitoes."

Howard, Dyer and Knab (1912). "The Mosquitoes of North and Central America and the West Indies."

James and Liston (1911). "The *Anopheline* Mosquitoes of India."

Mitchell, E. G. (1907). "Mosquito Life."

Patton and Cragg (1913). "A Text-book of Medical Entomology."

Ross, R. (1900). "Malaria and Mosquitoes."

Smith, J. B. (1904). "Report of New Jersey State Agricultural Experimental Station on Mosquitoes."

Theobald, G. V. (1907). "A Monograph of the *Culicidæ* or Mosquitoes."

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* "Parasitology," Vol. IV, 1911.

SOME OBSERVATIONS ON FEVERS INVESTIGATED IN QUITTAH, MARCH TO JUNE, 1914.

By G. E. H. Le Fanu, M.B., C.M. (Aberdeen), D.T.M. (Liverpool); *West African Medical Staff.*

Pending the arrival of a laboratory outfit, some preliminary work was done from March to June, 1914, and the results are attached. These are necessarily incomplete. Attention was given chiefly to children, and here the attempts to obtain material and continuous observation generally met with insurmountable difficulties.

At the very end of June the laboratory outfit arrived, but this work was unavoidably interrupted towards the end of July.

The cases number 106, 81 children and 25 adults from 17 years upwards. The following diseases occurred amongst them:—

Malaria	94 (worm infections in 11)
Yellow Fever	3
Helminthiasis	4
? Enteritis	1
Typhoid Fever... ...	2 (1 doubtful)
Pulmonary Congestion...	1
Undiagnosed	1

Malarial parasites were found in 88 of the cases diagnosed as Malaria:—

Subtertian	in	55
Tertian	,,	19
Quartan	,,	2
Subtertian and tertian ...	,,	4
Tertian and Quartan ...	,,	2
Quartan and *plasmodium tenue*	,,	1*
Species not determined ...	,,	5

* An account of this specimen was published by Prof. Stephens in the "Annals of Tropical Medicine and Parasitology," Vol. IX., No. 1, of 18th March, 1915.

Some data regarding the occurrence of albuminuria and jaundice are embodied in Table I. Albuminuria was found in a number of children under 2 years of age, the youngest only 8 months old.

Three cases of Yellow Fever were observed. In one (No. 26), which was fatal, there could be no doubt as to the diagnosis. In the second (Case 63) there seems to have been a latent malarial infection, as careful examination of the thick films repeatedly revealed the presence of pigment, though no parasites were found until the 8th day. The third case (No. 98) was slight and of short duration.

In the two cases of typhoid fever, the bacterial infection could not be determined, as the means to carry out the necessary tests and cultures did not exist. In the second case bacilluria was observed.

Bodies which seemed identical with *paraplasma* were repeatedly noticed, and ringed specimens from Cases 90, 96, 98 and 99 were forwarded (with letter of 25th June, 1914).

Table II. shows the results of examinations of fæces for ova, &c., carried out at Quittah and Lome. In 47 out of the total of 244, ankylostome infection was found. This is a very low percentage, and is probably explained by the majority of the cases examined being town dwellers, and therefore living in more satisfactory hygienic surroundings than the population of the "bush." About 50 per cent. of the cases showed definite symptoms of ankylostomiasis. Of these 8 died (2 at Quittah and 6 in Lome). The disease was confirmed postmortem in one case.

TABLE I.

LIST OF CASES WITH ALBUMINURIA AND JAUNDICE

(Fever Cases, Quittah—March to June, 1914.)

Case Number.	Sex.	Age.	Albuminuria.	Jaundice.	Worms.	Malaria.	Yellow Fever.	Typhoid.	Undiagnosed.	Remarks.
1	M	$4\frac{6}{12}$	††	*	?	§	—	—	—	—
11	F	7	?	†	?	§	—	—	—	—
13	M	12	†	*	*Ascaris l.*	*	—	—	—	—
17	M	Adult	†	*	?	§	—	—	—	? Gonorrhœa
26	F	28	†††	†††	*Ascaris l.* (post mortem)	*	§	—	—	Died
36	M	1	†	*	?	§	—	—	—	—
37	M	6	†††	*	*Ascaris l.*	§	—	—	—	—
38	M	5	†	*	*Ascaris l.*	§	—	—	—	—
41	F	$\frac{8}{12}$	†	*	?	§	—	—	—	—
42	F	10	†	*	?	§	—	—	—	—
46	M	12	††	††	*Ascaris l.*	§	—	—	—	—
47	M	2	††	*	*	§	—	—	—	Died
48	M	4	*	†	?	§	—	—	—	—
49	F	23	†	†	*Rhabdonema*	§	—	—	—	—
50	M	12	†	*	?	§	—	—	—	—
53	F	6	†	*	{ *Ascaris l.* ... *Schistosomum m.* }	§	—	—	—	—
59	M	25	†††	*	*Ankylostomum d.* ...	*	—	—	—	Ankylostomiasis
60	F	$1\frac{6}{12}$	†	*	?	§	—	—	—	—
62	M	$1\frac{6}{12}$	†	*	?	§	—	—	—	—
63	M	26	†††	††	*Ascaris l.* and *Ankylostomum d.*	*	§	—	—	—
66	F	5	†	*	?	§	—	—	—	—

† Slight.
†† Marked.
††† Very marked.

? Not examined.
* Absent.
§ Present.

TABLE I.—continued.

	Case Number.	Sex.	Age.	Albuminuria.	Jaundice.	Worms.	Malaria.	Yellow Fever.	Typhoid.	Undiagnosed.	Remarks.
	71	M	5	†	*	?	§	—	—	—	—
	74	F	16	††	*	?	§	—	—	—	—
	75	F	$1\frac{6}{12}$	†	*	?	§	—	—	—	—
	76	F	6	†	*	?	§	—	—	—	—
	83	M	6	†	*	?	§	—	—	—	—
	84	M	26	††	*	*Rhabdonema*	*	—	—	—	Pulmonary congestion
	85	F	28	*	†	*Trichocephalus tr.* ...	§	—	—	—	—
	90	M	45	††	*	*Ascaris l.* and *Trichocephalus tr.*	*	—	§	—	—
	92	M	18	†	*	?	§	—	—	—	—
	96	M	22	†††	*	*Trichocephalus tr.* ...	*	—	—	—	Pulmonary congestion
	98	M	26	†	†	*Ascaris l.*	*	§	—	—	—
	99	M	17	†	†	?	*	—	—	§	—
	100	M	$1\frac{3}{12}$	†	*	?	§	—	—	—	—
	101	F	17	†	*	*	§	—	§	—	—
	104	F	6	†	*	?	§	—	—	—	—
	106	F	2	†	*	*Ascaris l.*	§	—	—	—	—
TOTALS ...	37	37	—	35	9	15	28	3	2	1	—

† Slight.
†† Marked.
††† Very marked.

? Not examined.
* Absent.
§ Present.

TABLE II.

TABLE SHOWING INFECTION WITH INTESTINAL WORMS, &c., IN QUITTAH AND LOME.

Parasites.	Quittah.	Lome.	Total.
Ascaris l.	39	28	67
Ankylostomum and *Necator*	11	34	45
Trichocephalus tr.	5	2	7
Oxyaris verm.	—	1	1
Rhabdonema	2	1	3
Schistosomum m.	1	2	3
Bilharzia tr.	—	3	3
Tænia (sp. undetermined)	—	7	7
Ankylostome and *Ascaris*	9	19	28
Ankylostome, *Ascaris* and *Trichocephalus*... ...	5	3	8
Ankylostome, *Ascaris*, *Trichocephalus* and *Rhabdonema*	1	—	1
Ankylostome, *Ascaris* and *Rhabdonema*	2	2	4
Ankylostome and *Trichocephalus*	4	1	5
Ankylostome and *Rhabdonema*	1	3	4
Ankylostome, *Ascaris* and *Schistosomum m.* ...	1	—	1
Ascaris and *Trichocephalus*	7	2	9
Ascaris, *Trichocephalus* and *Rhabdonema* ...	1	—	1
Ascaris and *Schistosomum*...	2	—	2
Rhabdonema and *Schistosomum*	—	1	1
Negative	23	21	44
TOTALS	114	130	244

FEVER CASES, QUITTAH,

No.	Date.	Tribe, &c.	Age.	Sex.	Temperature at Time of taking Film.	Quinine.	Clinical Symptoms.	Parasites.
44	4.5.14	Alduna	1	M.	T. 101°F. P. 152	None	Fever ... ... Vomiting Convulsions Anæmia	Present ... ? species Pigmented mononuclears
45	4.5.14	Alduna	2	M.	T. 100°F. P. 128	None	Fever ... ... Cough Diarrhœa Splenic enlargement	Subtertian ... Pigmented mononuclears
46	11.5.14	Alduna	12	M.	T. 98·6°F. P. 78 E.T. 99·2° P. 74	None	Jaundice ... ... Frontal headache Epigastric pains Albuminuria	Subtertian ... Pigmented leucocytes
47	11.5.14	Alduna	2	M.	T. 101·4°F. P. 164	None	Fever ... ... Splenic enlargement Vomiting Severe anæmia Albuminuria	None ... Pigmented mononuclears
48	11.5.14	Alduna	4	M.	T. 101·2°F. P. 104	None	Fever ... ... Anæmia Vomiting Jaundice	Subtertian ... Pigmented mononuclears
49	12.5.14	Alduna	23	F.	T. 100°F. P. 104	None	Fever ... ... Pain in legs and back Frontal headache Splenic enlargement Anæmia (Tallquist 50%) Bilious vomit, 15.5.14 Albuminuria	Subtertian ...
50	12.5.14	Alduna	12	M.	T. 100·4°F. P. 72	None	Fever ... ... Pain back and legs Frontal headache Albuminuria	Quartan ...
51	13.5.14	Syrian	4	M.	T. 103°F. P. 130	None	Fever, 1 day	Tertian and subtertian Pigmented mononuclears
52	14.5.14	Alduna	21	M.	T. 99·6° F. P. 72	None	Fever ... ... Frontal headache Pain in back and legs Splenic enlargement	Subtertian ...
53	18.5.14	Alduna	6	F.	T. 102·6° F. P. 112	None	Fever ... ... Splenic enlargement Albuminuria	Subtertian ... Pigmented mononuclears

MAY AND JUNE, 1914.

Albuminuria.	Jaundice.	Cause of Jaundice.	Fever.	Cause of Fever.	Ova in Stools.	Diagnosis.	Remarks.
Urine not obtainable	None	—	Present	Malaria	None ... ... *E. hystolitica*	Malaria .. Complicated later on with Amœbic Dysentery	Died 15.5.14
Urine not obtainable	None	—	Present	Malaria	—	Malaria ...	Recovery
Present (marked opacity) up to 13.5.14 Bile pigment on 13th and 15th	Marked	? Helminthic (Ascarids)	Slight	Malaria	*Ascaris l.* ...	Malaria with Ascariasis	Recovery
Present (opacity)	None	—	Present	Malaria	None found ...	Malaria ...	Died 14.5.14
None ... ... Compound Protein	Slight on 14.5.14	?	Present	Malaria	—	Malaria ...	Recovery
Present (slight) up to 16.5.14 No bile, &c.	Present, fading on 16.5.14	? Hæmatogenous	Present	Malaria	*Rhabdonema* embryos numerous	Malaria with Strongyloid infection	Recovery
Present (slight)	None	—	Present	Malaria	—	Malaria ...	Recovery
Urine not obtainable	None	—	Present	Malaria	—	Malaria ...	Recovery
None	None	—	Present	Malaria	—	Malaria ...	Recovery ? Reinfected. Same case as No. 24
Present (slight) up to 22.5.14. Recurred 26.6.14	None	—	Present	Malaria	*Ascaris l.* ... *Schistosomum m.*	Malaria with Helminthiasis	Recovery

No.	Date.	Tribe, &c.	Age.	Sex.	Temperature at time of taking Film.	Quinine.	Clinical Symptoms.	Parasites.
54	18.5.14	Alduna	$\frac{9}{12}$	M.	T. 100° F. P. 120	None	Fever ... ... Diarrhœa Stomatitis	? Subtertian... Pigmented mononuclears
55	18.5.14	Alduna	2	F.	T. 105° F. P. 180	None	Fever ... ... Splenic enlargement Severe anæmia Vomiting	Subtertian ... Pigmented mononuclears
56	19.5.14	Mulatto	4	M.	T. 100·8° F. P. 124	None	Fever ... ... Splenic enlargement Impetigo	Subtertian ... Pigmented mononuclears
57	19.5.14	Alduna	$4\frac{5}{12}$	F.	T. 103·4° F. P. 142	None	Fever ... ... Headache Epigastric pain Diarrhœa Cough Severe anæmia	Subtertian ... Pigmented leucocytes
58	21.5.14	Alduna	5	F.	T. 98° F. P. 100	None	Diarrhœa ... ... Bronchitis Splenic enlargement	None ... Copious pigment in thick film
59	21.5.14	Alduna	25	M.	T. 102·7° F. P. 104	None	Fever ... ... Frontal headache Pains in legs and abdomen Albuminuria	None ...
60	22.5.14	Alduna	$1\frac{6}{12}$	F.	T. 104·8° F. P. 140	None	Fever ... ... Albuminuria	Subtertian ... Pigmented mononuclears
61	22.5.14	Alduna	$1\frac{7}{12}$	F.	T. 104°F. P. 139	None	Fever ... ... Splenic enlargement	Subtertian ... Pigmented mononuclears
62	23.5.14	Alduna	$1\frac{1}{2}$	M.	T. 103·8°F. P. 176	None	Fever ... ... Splenic enlargement Albuminuria	Subtertian ... Pigmented mononuclears
63	23.5.14	Kposo	26	M.	T. 101·8°F. P. 140	None	Fever ... ... Jaundice Epigastric pain Photophobia Vertigo Albuminuria Splenic enlargement on 30.5.14	None ... Subtertian on 30.5.14
64	25.5.14	Alduna	$1\frac{6}{12}$	F.	T. 104°F. P. 160	None	Fever ... ... Diarrhœa	Subtertian ...
65	25.5.14	Alduna	$\frac{4}{12}$	F.	T. 100°F. Pulse uncountable	None	Fever ... ... Splenic enlargement	Subtertian ...

MAY AND JUNE, 1914—*continued.*

Albuminuria.	Jaundice.	Cause of Jaundice.	Fever.	Cause of Fever.	Ova in Stools.	Diagnosis.	Remarks.
Urine not obtainable	None	—	Present	Malaria	—	Malaria with Stomatitis	Recovery
None	None	—	Present	Malaria	*Ascaris l.* ...	Malaria with Ascariasis	Recovery
None	None	—	Present	Malaria	—	Malaria with Impetigo	Recovery
None	None	—	Present	Malaria	*Ascaris l.* ...	Malaria with Ascariasis	Recovery
Compound protein	None	—	?	—	—	Malaria with Bronchitis	Recovery
Severe and persistent	None	—	Present	? Helminthic	*Ankylostomum d.*	Ankylostomiasis	Improved. Refused treatment. (*See* Notes)
Present (slight)	None	—	Present	Malaria	—	Malaria ...	Recovery
None	None	—	Present	Malaria	—	Malaria ...	Recovery
Present (trace)	Present	—	Present	Malaria	—	Malaria ...	Recovery
Severe	Present	?	Present	Yellow fever	*Ankylostomum d.*	Yellow fever	Recovery "Seidelin body" on 26.5.14 (*See* Notes)
Urine not obtainable	None	—	Present	Malaria	None	Malaria ...	Recovery
Urine not obtainable	None	—	Present	Malaria	—	Malaria ...	Recovery

No.	Date.	Tribe, &c.	Age.	Sex.	Temperature at time of taking Film.	Quinine.	Clinical Symptoms.	Parasites.
66	26.5.14	Alduna	5	F.	T. 101·6°F. P. 144	None	Fever ... ... Splenic enlargement	Subtertian ... Pigmented mononuclears
67	26.5.14	Alduna	6	M.	T. 99·6°F.	None	Fever ... ... Splenic enlargement	Subtertian ... Pigmented leucocytes
68	28.5.14	Alduna	3	F.	T. 100°F. P. 100	None	Fever ... ... Headache Vomiting Splenic enlargement	None found... Many pigmented mononuclears
69	28.5.14	Alduna	6	M.	T. 101·8°F. P. 102	None	Fever ... ... Vomiting Epigastric tenderness Frontal headache	Subtertian ... Pigmented mononuclears
70	28.5.14	Alduna	$2\frac{6}{12}$	F.	T. 105°F. P. 150	None	Fever	Subtertian ... Pigmented leucocytes
71	29.5.14	Alduna	5	M.	T. 104·6°F. P. 109	None	Fever ... ... Convulsions	Subtertian ...
72	29.5.14	Alduna	6	F.	T. 99°F. P. 100	None	Fever ... ... Vomiting	Subtertian ...
73	30 5.14	Alduna	$4\frac{6}{12}$	M.	T. 103°F. P. uncountable	None	Fever ... ... Strabismus Vertical nystagmus Tonic spasms Trismus Head retraction Kernig's sign Coma Splenic and Lepatic enlargement	Subtertian ... (in enormous numbers)
74	30.5.14	Alduna	16	F.	T. 100°F. P. 98	None	Fever ... ... Frontal headache Pain in neck, back and legs Anæmia Splenic enlargement	Subtertian ...
75	1.6.14	Alduna	$1\frac{6}{12}$	F.	T. 103·6°F. P. 160	None	Fever ... ... Convulsions Stupor Vomiting	Subtertian ...

MAY AND JUNE, 1914—*continued.*

Albuminuria.	Jaundice.	Cause of Jaundice.	Fever.	Cause of Fever.	Ova in Stools.	Diagnosis.	Remarks.
Present (slight)	None	—	Present	Malaria	—	Malaria ...	Recovery
Urine not obtainable	None	—	Present	Malaria	—	Malaria ...	Recovery
None ... ... Compound protein	None	—	Present	Malaria	—	Malaria ...	Recovery
None	None	—	Present	Malaria	—	Malaria ...	Recovery
None	None	—	Present	Malaria	—	Malaria ...	Recovery
Present (slight opalescence)	None	—	Present	Malaria	—	Malaria ...	Recovery
Urine not obtainable	None	—	Present	Malaria	*Ascaris l.* ...	Malaria with Ascariasis	Recovery
Urine not obtainable	None	—	Present	Malaria	—	Malaria ...	Died 2 p.m., 30.5.14
Present (marked)	None	—	Present	Malaria	—	Malaria ...	Recovery
Present (trace) ...	None	—	Present	Malaria	—	Malaria ...	Recovery

No.	Date.	Tribe, &c.	Age.	Sex.	Temperature at time of taking Film.	Quinine.	Clinical Symptoms.	Parasites.
76	1.6.14	Alduna	6	F.	T. 98·8°F. P. 140	None	Fever	Subtertian ...
77	1.6.14	Alduna	$\frac{4}{12}$	F.	T. 103°F. P. 176	None	Fever ... ... Colic Convulsions Diarrhœa	None ... No pigment in thick Film
78	2.6.14	Alduna	4	M.	T. 100·4°F. P. 100	None	Fever ... ... Abdominal pain	Subtertian ... Pigmented leucocytes
79	4.6.14	Alduna	36	M.	T. 99·3°F. P. 88	None	Fever	Subtertian ...
80	4.6.14	Alduna	7	M.	T. 99·6°F. P. 88	None	Fever ... ... Colic	Subtertian ...
81	4.6.14	Alduna	26	F.	T. 100·2°F. P. 104	None	Fever ... ... Anæmia Œdema, legs and feet	Tertian ...
82	4.6.14	Alduna	7	M.	T. 99·8°F. P. 89	None	Fever ... ... Splenic enlargement	Subtertian ...
83	4.6.14	Alduna	6	M.	T. 104°F. P. 117	None	Fever ... ... Headache Conjunctival injection Splenic enlargement Vomiting	Subtertian ..
84	5.6.14	Grunshi	26	M.	T. 101·6°F. P. 96	None	Fever ... ... Tenderness over liver Pulmonary congestion Albuminuria	None ..
85	5.6.14	Alduna	28	F.	T. 99°F. P. 84	None	Fever ... ... Pain chest and back	Subtertian ...
86	5.6.14	Grunshi	$\frac{9}{12}$	M.	T. 104·8°F. P. 116	None	Fever ... ... Splenic enlargement	Subtertian .

MAY AND JUNE, 1914—*continued.*

Albuminuria.	Jaundice.	Cause of Jaundice.	Fever.	Cause of Fever.	Ova in Stools.	Diagnosis.	Remarks.
Present (trace) ...	None	—	Present	Malaria	—	Malaria ...	Recovery
Urine not obtainable	None	—	Present	?	None	? Enteritis ...	Died 11.6.14
None	None	—	Present	Malaria	*Ascaris l.* ...	Malaria with Ascariasis	Recovery
None (large mucous casts)	None	—	Present	Malaria	—	Malaria ...	Recovery
None	None	—	Present	Malaria	*Ascaris l.* ...	Malaria with Ascariasis	Recovery
None ... ... Compound protein Epithelial casts and débris	None	—	Present	Malaria	—	Malaria ...	Recovery
None	None	—	Present	Malaria	—	Malaria ...	Recovery
Present (trace) ...	None	—	Present	Malaria	—	Malaria ...	Recovery
Present (marked) Bile salts on 6.6.14	None	—	Present	?	*Rhabdonema* embryos	Helminthiasis with pulmonary congestion	Recovery (*See* Notes)
None	Slight	?	Present	Malaria	*Trichocephalus tr.* *E. hystolitica* on 12.6.14	Malaria followed by Dysentery	Recovery
None	None	—	Present	Malaria	—	Malaria ...	Recovery

No.	Date.	Tribe.	Age.	Sex.	Temperature at time of taking Film.	Quinine.	Clinical Symptoms.	Parasites.
87	8.6.14	Alduna	1	M.	T. 103°F. P. 120	None	Fever ... ... Purulent ophthalmia Cough	Subtertian ...
88	11.6.14	Alduna	7	F.	T. 101·6°F. P. 130	None	Fever	Tertian ...
89	11.6 14	Alduna	1	M.	Not taken	None	Fever ... ... Stupor	Subtertian ...
90	11.6.14	Alduna	45	M.	*See* Notes	None	Fever ... ... Conjunctival injection Splenic enlargement Albuminuria	None ...
91	11.6.14	Alduna	$2\frac{6}{12}$	M.	T. 98°F. P. 76	None	Fever	Subtertian ...
92	11.6.14	Alduna	18	M.	T. 100°F. P. 119	None	Fever ... ... Headache Vomiting Diarrhœa Conjunctival injection Albuminuria	Tertian ...
93	12.6.14	Alduna	Adult	F.	T. 100°F. P. 99	None	Fever ... ... Articular pain Anæmia	Subtertian ...
94	12.6.14	European	43	M.	T. 98·4°F. P. 144	None	Fever ... ... Vomiting (? alcoholic)	Tertian ...
95	15.6.14	Alduna	2	F.	T. 102°F. P. 119	None	Fever	Subtertian ...
96	15.6.14	Alduna	22	M.	T. 100·3°F. P. 96	None	Fever ... ... Pulmonary congestion Albuminuria	None ...
97	15.6.14	Alduna	4	F.	T. 103·8°F	None	Fever ... ... Splenic enlargement Anæmia	Tertian and Subtertian

MAY AND JUNE, 1914—*continued.*

Albuminuria.	Jaundice.	Cause of Jaundice.	Fever.	Cause of Fever.	Ova in Stools.	Diagnosis.	Remarks.
Urine not obtainable	None	—	Present	Malaria	—	Malaria with Ophthalmia	Recovery
None	None	—	Present	Malaria	—	Malaria ...	Recovery
None ... ... Compound protein	None	—	Present	Malaria	—	Malaria ...	Recovery
Present (marked)	None	—	Present	? Typhoid	*Ascaris l.* ... *Trichocephalus tr.*	Typhoid ...	Recovery "Seidelin bodies" on 13.6.14 (*See* Notes)
None	None	—	Present	Malaria	—	Malaria ...	Recovery
Present (slight)	None	—	Present	Malaria	—	Malaria ...	Recovery
None	None	—	Present	Malaria	—	Malaria ...	Recovery
None	None	—	Present	Malaria	None	Malaria ...	Recovery
Urine not obtainable	None	—	Present	Malaria	—	Malaria ...	Recovery
Severe ... ... (? Gonorrhœal)	None	—	Present	Pulmonary congestion	*Trichocephalus tr.*	Pulmonary congestion	Recovery "Seidelin bodies," 15 and 16.6.14
Urine not obtainable	None	—	Present	Malaria	—	Malaria ...	Recovery

No.	Date.	Tribe.	Age.	Sex.	Temperature at Time of taking Film.	Quinine.	Clinical Symptoms.	Parasites.
98	17.6.14	Atsina	26	M.	T. 102·8°F. P. 85	None	Rigor ... ... Headache Loin pains Fever Faget's sign Albuminuria Conjunctival injection	None ...
99	17.6.14	Alduna	17	M.	T. 99·2° F. P. 74	None	Rigor ... ... Fever Jaundice Pain over liver Vomiting Albuminuria	None ...
100	19.6.14	Alduna	$1\frac{3}{12}$	M.	T. 103° F. P. 140	None	Fever ... ... Vomiting Albuminuria	Tertian ...
101	22.6.14	Alduna	17	F.	T. 102·6° F. P. 120	None	Fever ... ... Headache Albuminuria	Present (very scarce) ? species
102	23.6.14	Alduna	7	M.	T. 103·6° F. P. 140	None	Fever ... ... Headache Splenic enlargement	Tertian Many pigmented leucocytes
103	24.6.14	Mulatto	12	M.	T. 104·8° F. P. 145	None	Rigor ... ... Fever Headache Splenic enlargement	Tertian ...
104	25.6.14	Alduna	6	F.	T. 101·8° F. P. 120	None	Fever ... ... Diarrhœa Cough Albuminuria	? Quartan Pigment in mono- and polynuclears
105	25.6.14	Alduna	$1\frac{1}{2}$	F.	T. 99·6° F. P. 120	None	Fever ... ... Splenic enlargement	Tertian ...
106	25.6.14	Alduna	2	F.	Not noted	None	Fever ... ... Splenic enlargement Albuminuria Anæmia	Tertian ...

May and June, 1914—*continued.*

Albuminuria.	Jaundice.	Cause of Jaundice.	Fever.	Cause of Fever.	Ova in Stools.	Diagnosis.	Remarks.
Present (slight)...	Present	? Hæmatogenous	Present	Yellow Fever	*Ascaris l.* ...	Yellow Fever	Recovery (*See* Notes)
Present (slight) on 17.6.14 only	Present	?	Present	?	—	?	Recovery
Present (opacity)	None	—	Present	Malaria	—	Malaria ...	Recovery
Present (slight)...	None	—	Present	? Typhoid	None	? Typhoid ...	Recovery "Seidelin bodies" found (*See* Notes)
None	None	—	Present	Malaria	—	Malaria ...	Recovery
None	None	—	Present	Malaria	—	Malaria ..	Recovery
Present ... .. Deposit contains granular casts and epithelial débris	None	—	Present	Malaria	—	Malaria ...	Recovery
Urine not obtainable	None	—	Present	Malaria	—	Malaria ...	Recovery
Present (trace) ...	None	—	Present	Malaria	*Ascaris l.* ...	Malaria with Ascariasis	Recovery

Case 59.

THE CASE OF OKPITA

21.5.14.—Okpita, male, 25, Alduna. "I had abdominal pain yesterday morning. Fever commenced last night."

Temperature 102, pulse 104, weak and compressible. Pain in legs and lower part of abdomen. Slight epigastric tenderness. Eyes moist and slightly injected. Blood: No parasites. Urine: Heavy deposit of albumin on boiling. ℞ Sp. Aetheris Nitr. ʒss, Liq. Am. Acet. Con. ʒss. statim.

2.30 p.m. Temperature 100, pulse 82, tension increased. Urine, 6 ozs.; albumin $\frac{1}{4}$.

3.20 p.m. Blood: No parasites and no pigment.

8.30 p.m. Temperature 99·4, pulse 82-84, of fair tension. Urine, 8 ozs., albuminous. Strong sweat.

22.5.14.—Urine: 5.30 a.m., 2 ozs.; albumin $\frac{1}{3}$.

7.5 a.m. Urine, 7 ozs., albumin $\frac{1}{4}$.

8 a.m. Temperature, 99. Blood: No pigment and no parasites.

1.5 p.m. Urine: Albumin $\frac{1}{3}$.

3.15 p.m. Temperature 98·6, pulse 95. Blood: No pigment and no parasites.

7.30 p.m. Blood: No pigment and no parasites.

9 p.m. Urine: Albumin $\frac{1}{3}$.

23.5.14.—Temperature 98·4, pulse 76. Urine, albumin $\frac{2}{7}$. Stool: Very numerous ankylostome eggs.

12 a.m. Urine 6 oz., albumin $\frac{1}{4}$.

3.40 p.m. Temperature 98·4, pulse 80. Discharged under observation.

24.5.14.—Temperature 98, pulse 76. Albumin $\frac{2}{5}$.

25.5.14.—Urine, albumin $\frac{2}{5}$.

1.6.14.—Temperature 98·4, pulse 75. Urine: Albumin $\frac{1}{20}$.

Is suffering from ankylostomiasis, and refuses treatment.

Medical Department, Gold Coast Colony.

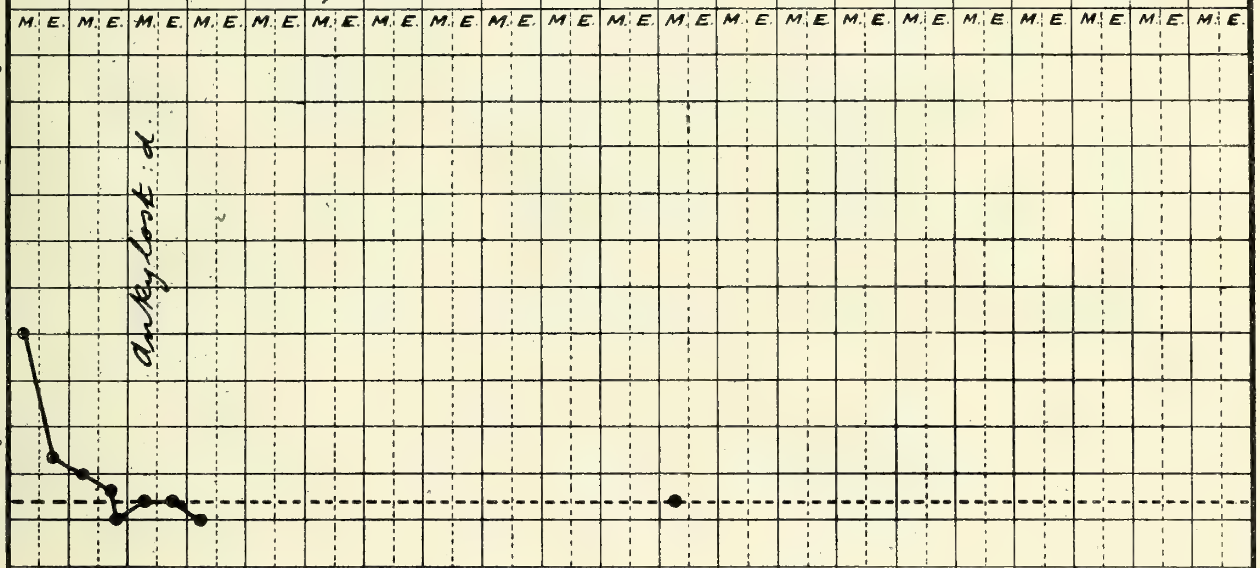
Name of Station Quittah

CLINICAL CHART OF TEMPERATURE

Name Okpita, male Age 25 Disease ____ Result ____

ate of Observation	May 21.	22.	23.	24.	25.	26.	27.	28.	29.	30.	31.	June 1.
ay of Disease	2.	3.	4.	5.	6.	7.						
	M. E.	M. E.	M. E.	M. E.	M. E.	M. E.	M. E.	M. E.	M. E.	M. E.	M. E.	M. E.

Fahrenheit 108° 107° 106° 105° 104° 103° 102° 101° 100° 99° 98° 97°



108° 107° 106° 105° 104° 103° 102° 101° 100° 99° 98° 97° Fahrenheit

ols Number												
Pulse M.	104.		76.	76.								75.
Pulse E.	83.	95.	80.									
Resp. M.												
Resp. E.												
Ozs. in 24 hours												
Reaction of												
Specif. Gr. of												
Colour of												
Urea (amount)												
Albumen in	+	+	+	+								+
Solids in												
Micros. Sedimts.												

Observations taken at a.m. and p.m.

Admitted to Hospital	Description	Discharged
21 May 1914.	Goldsmith's Apprentice.	23 May 1914.

Case 63.

THE CASE OF KPESU.

Kpesu, male, aged 26, scavenger, from Kposo in Togoland, resident five months in Quittah, was admitted to hospital 23.5.1914.

"He was suddenly taken ill on May 20th, while working in the market-place. The illness commenced with abdominal pain, then pain in back, shoulders and neck, and strong frontal headache. He had a serious rigor lasting until the next day, and was confined to his bed with a strong fever for three days, during which time he was very weak, could not take food, and had looseness of the bowels. On the 23rd he felt a little better and came to hospital."

State on admission: Temperature 101·8, pulse 140. Marked prostrations. Tongue coated, cleaner at tip and edges. Vertigo. Eyes injected. Photophobia. Distinct jaundice of scleræ. Great tenderness to pressure over epigastrium. Spleen and liver not palpable—any handling causes great pain. Pain around shoulders and back of neck. No nausea. Urine: Acid, heavy deposit of albumin. Blood: No malarial or other parasites. Two pigmented leucocytes found in thick film after prolonged examination. Normoblasts.

Polynuclears	29·4
Lymphocytes	68·0
Mononuclears	1·6
Neutrophil Myelocytes	1·0
	100·0

11 a.m. Blood: No parasites and no pigment (examination $1\frac{1}{4}$ hours):—

Polynuclears	32·2
Lymphocytes	65·6
Irritation forms	0·2
Mononuclears	1·2
Neutrophil Myelocytes	0·8
	100·0

12 a.m. $3\frac{1}{2}$ ozs. urine: acid, high-coloured, slightly turbid. Albumin $\frac{1}{8}$. No bile salts or pigment. Deposit: A few pus cells and a few very small casts.

Patient states he had gonorrhœa since four months ago.

3.13 p.m. Urine 4 ozs.: acid, albumin $\frac{1}{10}$.

3.40 p.m. Temperature 102·6, pulse 120.

4.30 p.m. Blood: No parasites and no pigment (thick film, 15 minutes).

24.5.14.—5.50 a.m. Urine $10\frac{1}{2}$ ozs., acid, albumin $\frac{1}{10}$.

6 a.m. Temperature 99° F., pulse 78.

9.50 a.m. Temperature 98·4, pulse 75.

9.55 a.m. Urine: $6\frac{1}{2}$ ozs., acid, albuminous. Stool: Eggs of *Ascaris l.*, and *ankylostomum.*

10.45 a.m. Blood: No parasites, 1 pigmented leucocyte in thick film (15 minutes).

11 a.m. Jaundice pronounced. Tongue clean at tip and edges, whitish fur on dorsum, the papillæ showing as red points. Glabellar headache and severe epigastric pain. Marked prostration. Pulse 94.

3 p.m. No headache. Pain over epigastrium and liver. Temperature 99·7, pulse 81, weak and compressible. Blood: No parasites and no pigment ($\frac{1}{2}$ hour).

4.30 p.m. Temperature 100, pulse 99.

6.40 p.m. Urine $6\frac{1}{2}$ ozs., albumin = $\frac{1}{10}$.

6.45 p.m. Temperature 101, pulse 100.

8.30 p.m. Temperature 98·8, pulse 76. Epigastric pain.

25.5.14.—1.5 a.m. Urine 7 ozs., acid, albuminous

3.50 a.m. Urine $6\frac{1}{2}$ ozs., acid, albuminous.

8.30 a.m. Urine $3\frac{1}{2}$ ozs., high-coloured, turbid, deposit contains granular casts, albumin $\frac{1}{20}$.

9.20 a.m. Temperature 97·8, pulse 96. Blood: No parasites, 2 pigmented mononuclears in thick film.

2.40 p.m. Temperature 98·6, pulse 92. Blood: No parasites and no pigment. Urine $7\frac{1}{2}$ ozs., clear, albumin = transparent opacity, no deposit on centrifuging. No headache or epigastric tenderness. No splenic enlargement.

4.30 p.m. Urine $1\frac{1}{2}$ ozs., clear, acid, albumin = opacity.

7 p.m. Urine 9 ozs., clear, albumin = opacity.

9.20 p.m. Urine $8\frac{1}{2}$ ozs., clear, acid, albumin = faint opacity. Epigastric pain. No headache. Temperature 97·4, pulse 98, feeble and compressible. Patient is very weak.

26.5.14.—8 a.m. Urine $6\frac{1}{2}$ ozs., high-coloured, clear, acid, albumin = transparent opacity.

10.45 a.m. Temperature 98·4, pulse 91. Jaundice is fading. Epigastric tenderness. No headache. Blood: No parasites and no pigment, 1 "Seidelin body."

3.10 p.m. Urine 6 ozs., clear, acid, albumin = transparent opacity.

4 p.m. Temperature 99·4, pulse 96. Blood: No parasites, 4 pigmented mononuclears in thick film ($\frac{3}{4}$ hour).

27.5.14.—6.30 a.m. Temperature 98·6, pulse 99. Urine 4 ozs., clear, very faint trace of albumin, and some compound protein. ℞ T. Strophanth. ♏x., T. Nucis Vomic., ♏x., T. Gent. Co. ♏x. Aq. ad ℥j. t.d.s.

3 p.m. Temperature 98·4, pulse 93. Tongue clean. Jaundice fading. Marked improvement of general condition: patient looks bright, feels stronger, no headache, etc. Appetite is asserting itself. Urine: Acid, clear, albumin = faint opacity.

28.5.14.—9 a.m. Urine: clear, acid, no deposit, albumin = opacity Temperature 98·4, pulse 75. Jaundice still distinct, but lessening.

10 a.m. Pulse 95. Discharged under observation.

29.5.14.—9 a.m. Urine acid, Albumin = marked opacity. Temperature 98·4, pulse 92. Jaundice present. Spleen and liver not palpable.

30.5.14.—3 p.m. Feels ill to-day. Temperature 100, pulse 100. Spleen palpable at costal margin. Blood: Tertian parasites. Quinine.

1.6.14.—Temperature 99·8, pulse 99. Jaundice very slight. Tongue clean. Spleen palpable. Urine: Albumin = lessening opacity.

Patient left the town without reporting himself again.

Diagnosis: Yellow Fever.

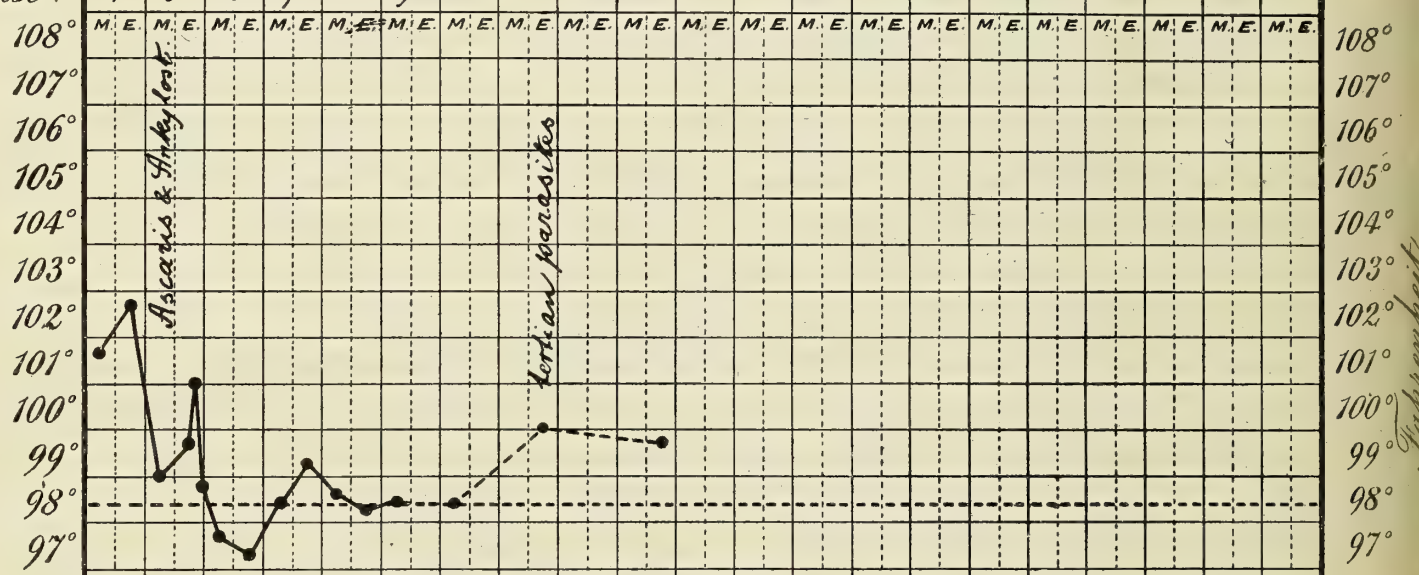
Medical Department, Gold Coast Colony.

Name of Station Quittah

CLINICAL CHART OF TEMPERATURE

Name Kpesu, male Age 26. Disease Y. F. Result Recovery

Date of Observation	May 23.	24.	25.	26.	27.	28.	29.	30.	31.	June 1.
Day of Disease	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
Pulse M.	140.	78.	96.	91.	99.	95.	92.	100.		
Pulse E.	120.	81/100	98.	96.	93.					99.
Albumen in Urine	+	+	+	+	+	+	+			+



Stools Number

Resp.

Urine: Ozs. in 24 hours; Reaction of; Specif. Gr. of; Colour of; Urea (amount); Albumen in; Solids in; Micros. Sedimts.

Admitted to Hospital	Description	Discharged
23 May 1914	Scavenger	28 May 1914.

Case 84.

THE CASE OF BATIA GRUNSHI.

5.6.14.—Batia Grunshi, male, 26, Grunshi, police constable. States he had "fever in bush. Came back five days ago. Yesterday pain all over." Temperature 101·6, pulse 96. Headache. Tongue flabby, coated, and indented. Tenderness over liver. Liver and spleen not palpable. Urine: Acid, albumin = marked opacity. Blood: No parasites.

℞ Phenacetin Compound gr. x. Diaphoretic mixture.

6.6.14.—Temperature 100, pulse 99. Urine dark brown, acid, albumin = marked opacity. Bile salts present (Hay's test).

2 p.m. Temperature 100, pulse 77. Tenderness over liver. Blood: No parasites.

7.6.14.—Temperature 100, pulse 99. Persistent pain over right lobe of liver. No enlargement of liver or spleen. Dulness and impaired breath over lower lobe of right lung. No adventitious sounds. Urine: Dark, turbid, trace of albumin, no bile or bile salts. Blood: No parasites. Stool: *Rhabdonema.*

2.30 p.m. Temperature 102·6, pulse 92. Slight headache. Urine: Clear, acid, albumin a trace. No bile, &c.

8.6.14.—7.55 a.m. Temperature 101, pulse 99. Urine: Albumin = opacity.

3 p.m. Temperature 100, pulse 99.

9.6.14.—7 a.m. Temperature 100, pulse 98. Urine: Dark, clear, acid, albumin = dense opacity.

4 p.m. Temperature 99·9, pulse 98.

10.6.14.—Morning, temperature 99·6; evening, temperature 98·6.

11.6.14.—Morning, temperature 98·8. Very harsh, almost tubular breathing over right base. albumin = opacity. Discharged.

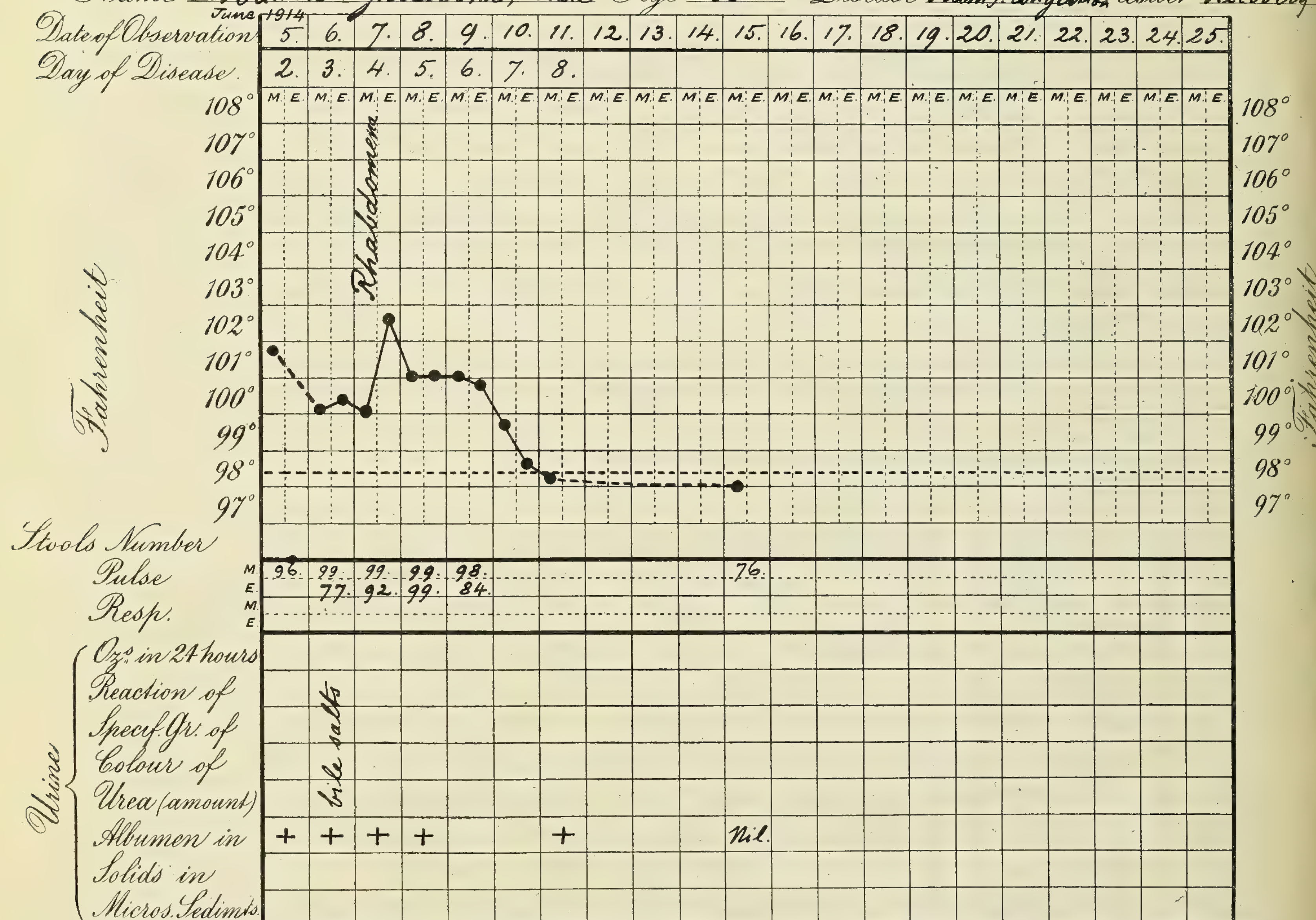
15.6.14.—Temperature 98, pulse 76. Urine free from albumin. Chest has cleared up.

Medical Department, Gold Coast Colony.

Name of Station Quittah

CLINICAL CHART OF TEMPERATURE

Name Batia Grunshe, Male Age 26 Disease Pulm. congestion Result Recovery



Admitted to Hospital 5th June 1914.	Description Police Constable.	Discharged 11.6.14

Case 90.

THE CASE OF TETTEH.

11.6.14.—Tetteh, male, Alduna, from Jellerkophe. "Fever five days, all the time." Eyes injected. Pain in right eye. Temperature 103° F., pulse 100. Urine: Clear, acid, albumin = marked opacity. No parasites.

4.5 p.m. Temperature 103·6° F., pulse 80. Sudden profuse sweat. No parasites.

12.6.14.—6.40 a.m. Temperature 103, pulse 101. Urine: Albumin = marked opacity.

10 a.m. Temperature 102·9° F.

12.30 p.m. Temperature 103·2, pulse 88. Blood: No parasites.

4 p.m. Temperature 104·2, pulse 120. Pain in loins.

13.6.14.—6.55 a.m. Temperature 101, pulse 99.

11.30 a.m. Temperature 103·2, pulse 100. Fainted.

Stool: *Ascaris l.* and *Trichocephalus tr.* Blood: No parasites. Two Seidelin bodies.

4 p.m. Temperature 104° F., pulse 99. Blood: No parasites. Pain in back and "sore throat."

8 p.m. Temperature 103·2° F., pulse 88.

14.6.14.—7 a.m. Temperature 103, pulse 98.

9 a.m. Urine: Albumin = faint opacity.

12.15 a.m. Temperature 103·2, pulse 83-86. Spleen enlarged. Some fulness of abdomen. Blood: No parasites.

4 p.m. Temperature 103·6° F., pulse 88. Pain in eyes.

6 p.m. Temperature 103·6° F., pulse 85. Blood: No parasites.

15.6.14.—7 a.m. Temperature 102·6, pulse 89.

8 a.m. Urine: Acid, albumin = transparent opacity.

10 a.m. Temperature 102, pulse 91.

4.30 p.m. Temperature 104, pulse 89. Cough. Spleen palpable.

16.6.14.—7 a.m. Temperature 100° F., pulse 82.

8.55 a.m. Urine: Albumin = slight opacity.

12 a.m. Temperature 102·6, pulse 82.

6 p.m. Temperature 102·6, pulse 84. Coughing frequently.

17.6.14.—Temperature 102·6, pulse 81. Urine: Albumin a trace.

4 p.m. Temperature 103·2° F., pulse 82.

7 p.m. Temperature 105, pulse 104. Sweating.

18.6.14.—8 a.m. Temperature 101·6, pulse 82. Urine, trace albumin.

2.30 p.m. Temperature 103, pulse 67. Urine, trace albumin.

7 p.m. Temperature 102, pulse 80. Stool after four days.

19.6.14.—7 a.m. Temperature 99·6, pulse 60. Urine, trace albumin.

11 a.m. Temperature 101·4° F., pulse 84.

6 p.m. Temperature 101·6, pulse 60. Sweating.

20.6.14.—Temperature 98·4, pulse 74. Urine: Albumin—a very faint trace.

7 p.m. Temperature 99·2, pulse 82.

21.6.14—Morning, temperature 98·4, pulse 75. Evening, temperature 98·2, pulse 76.

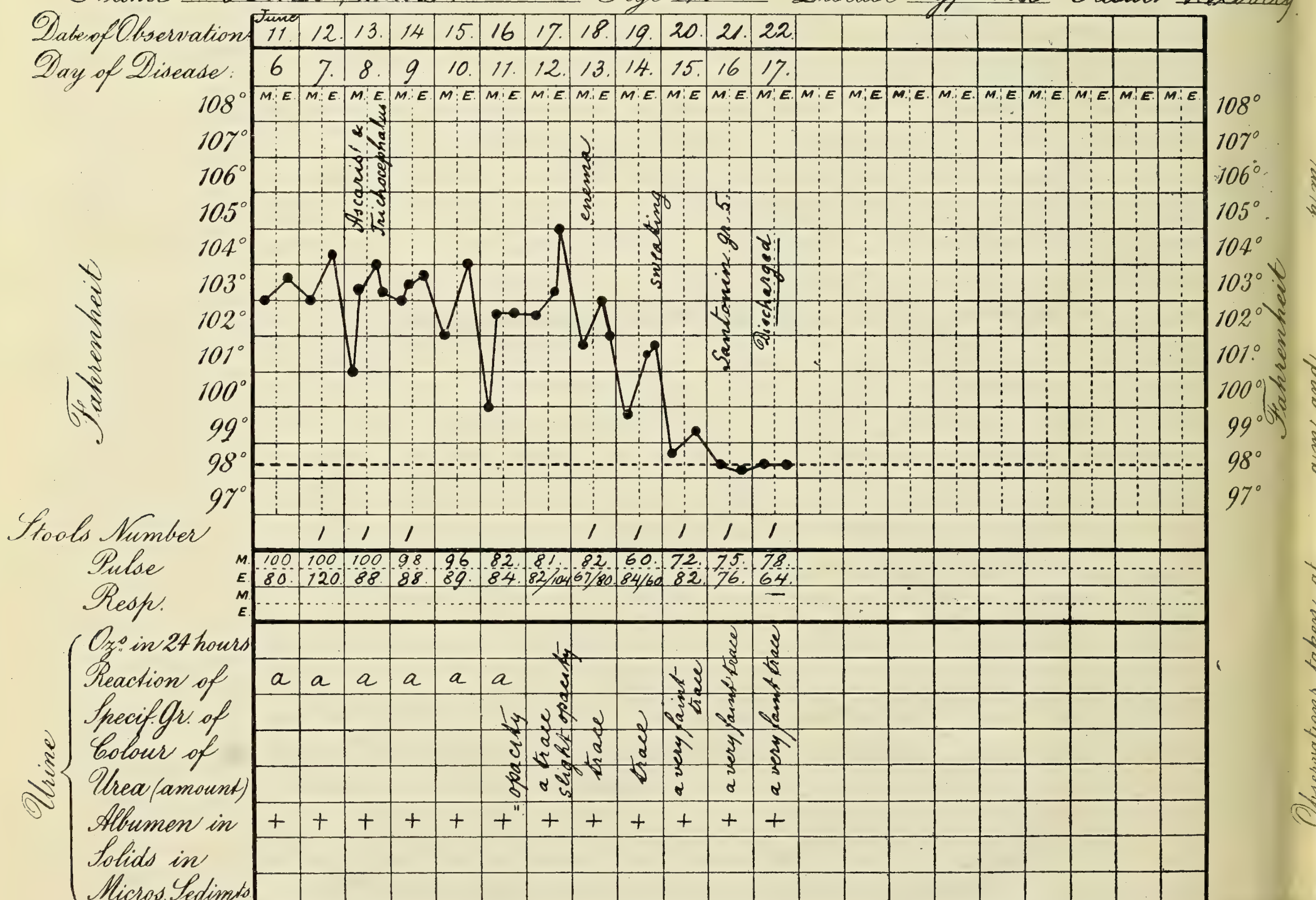
22.6.14.—Morning, temperature 98·4, pulse 78. Evening, temperature 99·4, pulse 64. Discharged.

Medical Department, Gold Coast Colony.

Name of Station Quittah

CLINICAL CHART OF TEMPERATURE

Name Tetteh, male. *Age* 45 *Disease* Typhoid *Result* Recovery



Admitted to Hospital	*Description*	*Discharged*
11. June 1914.	Farmer.	

Case 96

THE CASE OF LAURENCE NETAKO.

15.6.14.—Laurence Netako, male, 22, Alduna, clerk. "On the 12th, pain in the left of chest. Coughing since then. That day also strong fever, rigors during night. Next day spat blood after coughing. Has improved since then. Gonorrhœa six months ago."

On admission: Pain left side. Impaired breath—sounds over left lung, no adventitious sounds. Blood: No parasites. "Seidelin bodies" found.

3 p.m Temperature 100·6, pulse 99. Coughing. Urine: Strongly acid, contains gonorrhœal threads, albumin $\frac{1}{3}$.

16.6.14—Temperature 100·3, pulse 96. Coughing. Râles and rhonchi over left base. Urine: Albumin $\frac{1}{20}$. Blood: No parasites. "Seidelin bodies" found.

17.6.14.—Temperature 100, pulse 99. Urine albuminous, opacity on boiling. Pulmonary symptoms more pronounced. Stool: *Tricho-cephalus tr.* Blood: No parasites.

20.6.14.—Temperature 98·9, pulse 86. Slight bronchitic cough. No pain. Urine: A trace of albumin.

22.6.14.—Temperature 98·8, pulse 84. Urine: Albuminous.

23.6.14.—Urine: Albumin $\frac{1}{20}$

24.6.14.—Temperature 99, pulse 86. Urine: Small deposit of albumin.

25.6.14.—Temperature 99·4, pulse 89. Urine: Albumin = opacity.

26.6.14.—Temperature 98·4, pulse 88. Urine: Albumin $\frac{1}{20}$.

14.7.14.—Temperature normal. Urine: Albumin nil.

Case 98.

THE CASE OF KOFI.

17.6.14.—Kofi, male, 26, Atsim, police constable. Taken ill suddenly with rigor, pains in loins and violent headache. His temperature at 11 p.m. was 99, pulse 102. Hot fomentation.

On admission: Temperature 102·8, pulse 85. Urine: Compound protein, no albumin. Blood: No parasites. Stool: *Ascaris l.*

4 p.m. Temperature 103, pulse 92. Urine: Trace of albumin.

5 p.m. Temperature 102·6, pulse 83, regular, compressible. Conjunctivæ strongly injected. Tongue pointed, slightly coated on dorsum. All day there has been strong frontal headache and pains in loins.

7 p.m. Temperature 102, pulse 84.

18.6.14.—Temperature 98·8, pulse 74. Urine: Trace of albumin. Pain in loins and stomach. Tenderness over epigastrium No headache. Blood: No parasities. ? "Seidelin bodies."

2.30 p.m. Temperature 99·4, pulse 73, very regular. Urine: Trace of albumin. Blood: No parasites.

7 p.m. Temperature 99, pulse 63.

19.6.14.—7 a.m. Temperature 98·2, pulse 63. The eyes have a slight icteric tint. Urine: Trace of albumin.

11 a.m. Temperature 98·2, pulse 64.

6 p.m. Temperature 98·2, pulse 68.

20.6.14.—Temperature 98·4, pulse 75. Urine: No albumin.

4 p.m. Temperature 98, pulse 62. Icterus of scleræ has almost disappeared.

21.6.14.—Morning, temperature 98, pulse 74. Evening, temperature 98, pulse 56. Urine: No albumin.

22.6.14.—Morning, temperature 98·2, pulse 59. Urine: No albumin.

23.6.14.—Temperature 98·4, pulse 64. Urine: No albumin.

24.6.14.—Temperature 98·8, pulse 64. Urine: Faint trace of albumin.

25.6.14.—Temperature 98·8, pulse 70. Urine: No albumin.

26.6.14.—Temperature 98·4, pulse 78. Urine: No albumin.

27.6.14.—Temperature 98, pulse 76. Urine: No albumin.

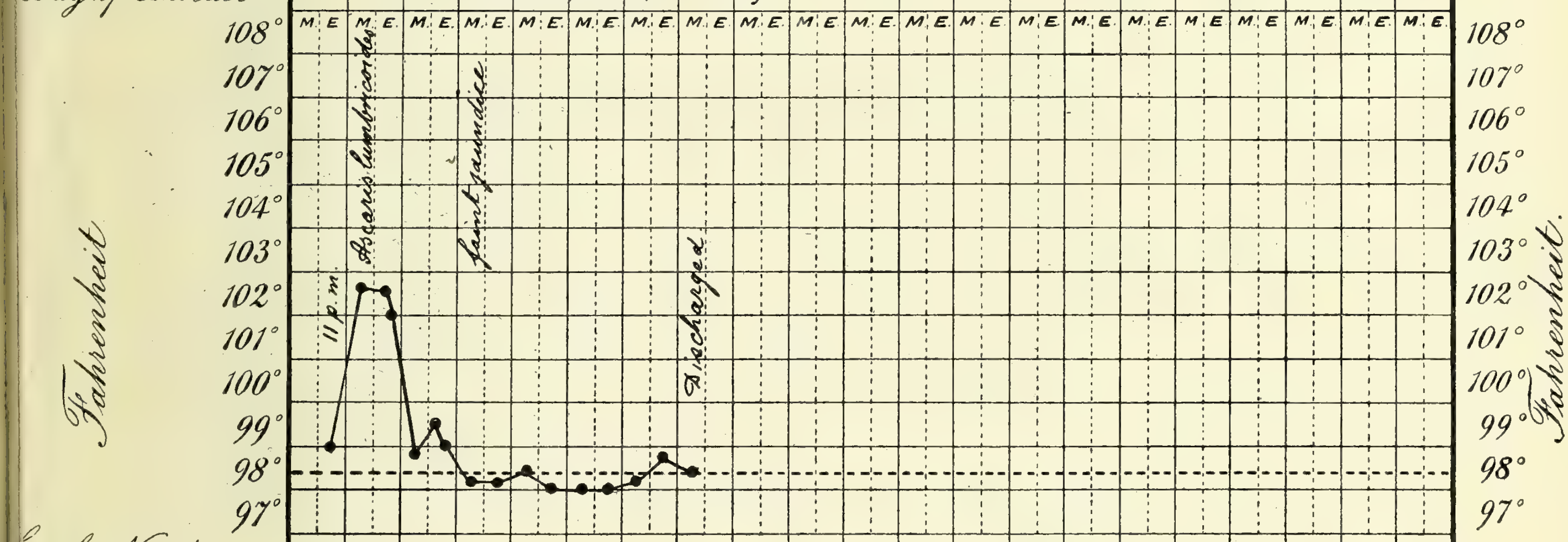
Medical Department, Gold Coast Colony.

Name of Station Quittah.

CLINICAL CHART OF TEMPERATURE

Name Kofi, male Age 26 Disease Y. F. Result

Date of Observation	June 16.	17.	18.	19	20.	21.	22.	23.	24.	25.	
Day of Disease	1	2.	3.	4.	5.	6.	7.	8.	9	10	
Stools Number											
Pulse M		85.	74.	63.	75	74.	59.	64.			
Pulse E	102	83/84	73/63	63.	62.	56.	66				
Resp. M											
Resp. E											
Urine: Ozs. in 24 hours	a ti of compound protein a trace										
Reaction of											
Specif. Gr. of											
Colour of											
Urea (amount)		trace	trace								
Albumen in	+	+	+	Nil	Nil	Nil	Nil.	Trace	Nil.	Nil.	Nil
Solids in											
Micros. Sedimts.											



Observations taken at a.m. and p.m.

Admitted to Hospital.	Description	Discharged
11 p.m. 16 June, 1914.	Police Constable.	

Case 101.

THE CASE OF GRAN TAMAKLU.

22.6.14.—Gran Tamaklu, female, 17, Alduna. States she has had fever and headache three days, with constipation. Temperature 102·6, pulse 120. Urine: No albumin. Blood: No parasites. Mist. alb. and calomel gr. iii.

23.6.14.—11 a.m. Temperature 101·8. Headache. Bowels have moved freely. Urine: Trace of albumin. Blood: No parasites, no pigment. ? "Seidelin bodies." Phenacetin Compound gr. x.

24.6.14.—Temperature 102·8, pulse 118. Headache. Urine: Trace albumin, and small deposit of epithelial débris. Blood: No parasites. ? "Seidelin bodies." Admitted to hospital.

25.6.14.—Temperature 102·2, pulse 90. Urine: Trace of albumin.

11 a.m. Temperature 102, pulse 104. Slight headache. Blood: Malarial parasites (? species) very scarce. One "Seidelin body" found after ¾ hour.

3 p.m. Temperature 103·4, pulse 104. No headache. Urine: Turbid, deposit on centrifuging: epithelial débris and clumps of bacilli.

5 p.m. Temperature 103·2, pulse 104.

6.30 p.m. Temperature 102·2, pulse 102

26.6.14.—Temperature 102, pulse 92. Urine: Trace of albumin. Blood: No parasites.

3.40 p.m. Temperature 103·8, pulse 100.

5.30 p.m. Temperature 103·2, pulse 102.

27.6.14.—Temperature 102, pulse 102.

3.30 p.m. Temperature 103·4, pulse 112.

6 p.m. Temperature 103·2, pulse 104. Slight headache.

For further temperature see chart. Albuminuria continued up to July 14, when urine was found free from albumin.

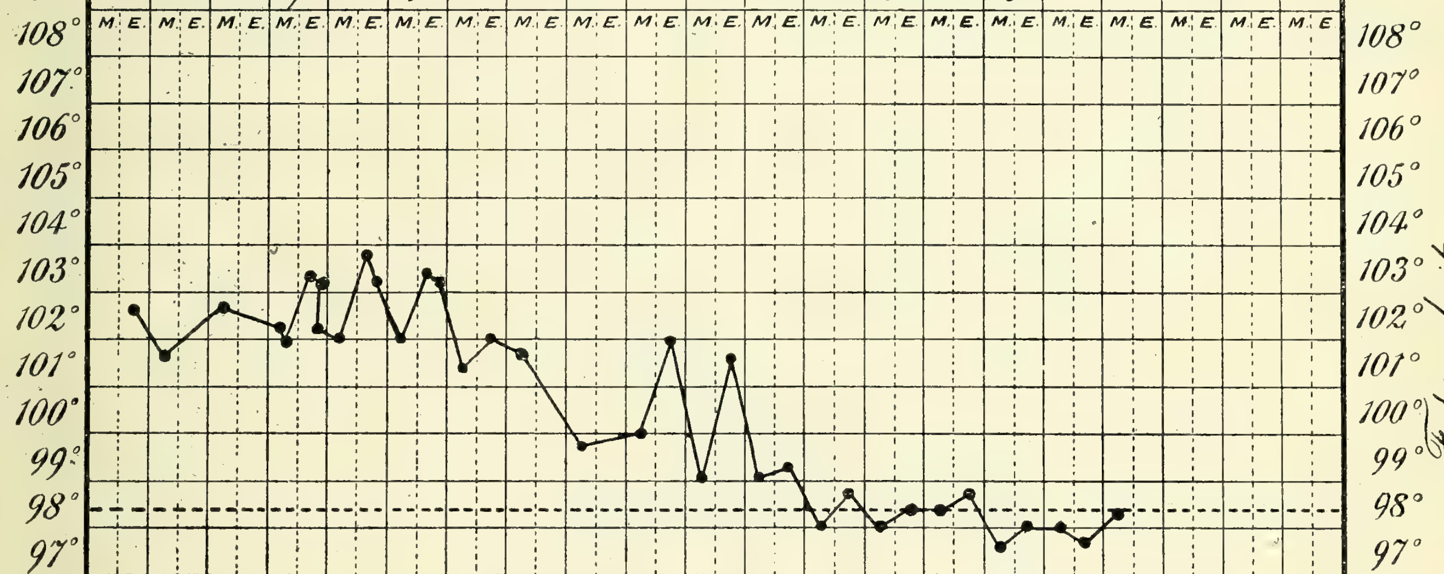
Medical Department, Gold Coast Colony.

Name of Station Quittah.

CLINICAL CHART OF TEMPERATURE

Name Gran Tamaklu. Fem. Age 17. Disease ? Typhoid Result Recovered

Date of Observation	June 22.	23.	24.	25.	26.	27.	28.	29.	30	July 1.	2.	3.	4.	5.	6.	7.					
Day of Disease	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18	19.					



		June 22.	23.	24.	25.	26.	27.	28.	29.	30	July 1.	2.	3.	4.	5.	6.	7.					
Stools Number																						
Pulse	M.			118	99/104	92.	102.	92.	99.	100.	99.	94.	94.	96.	80.	87.	88.	78.	74.			
	E.	120			104.	100/102	112/104	99			90.	97.	97.	88.	84.	88.	84.	62.				
Resp.	M.																					
	E.																					
Urine: Ozs. in 24 hours																						
Reaction of																						
Specif. Gr. of																						
Colour of			trace	trace	trace	v. faint trace	faint trace	continued up to 14th when urine free from albumen														
Urea (amount)																						
Albumen in		nil	+	+	+	+	+															
Solids in																						
Micros. Sedimts.																						

Observations taken at a.m. and p.m.

Admitted to Hospital. 22. June 1914.	Description.	Discharged 4 July 1914.

Treatment	Diet	Treatment